

UNITED STATES OF AMERICA
NATIONAL TRANSPORTATION SAFETY BOARD

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On behalf of the Bureau D'Enquetes et
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PIERRE JOUNIAUX

WITNESS SCHEDULE

<u>NUMBER</u>	<u>NAME AND AFFILIATION</u>
4 & 5	Captain Delvin Young A300 Fleet Standards Manager Mr. Asok Ghoshal Manager Simulator Engineering American Airlines
6	Captain Armand Jacob Experimental Test Pilot Engineering, Flight Operations Airbus
7	Dr. Fred Proctor Research Meteorologist Flight Dynamics and Control Division NASA
8, 9, 10, 11	Mr. Robert Jones Aerospace Engineer Mr. Don Stimson Aerospace Engineer Mr. Loran Haworth Human Factors Specialist Mr. Guy Thiel Flight test pilot FAA Transport Airplane Directorate FAA
12, 13	Mr. John Howford Chief Scientific and Tech Advisor Flight Loads and Aeroplasticity Mr. Henry Offerman II Aerospace engineer, Airframe FAA

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1 Manager for the A300, and I've been there since July of
2 2002.

3 Q And what are your current duties and
4 responsibilities, and the education and training that
5 you may have received to qualify for that position?

6 A My duties and responsibilities involve
7 oversight of training programs as well as
8 standardization of those training programs,
9 standardization of line pilots, as well as responsible
10 -- sharing in responsibilities for revisions and
11 updates and currency of flight manuals. And in the
12 past year it's also been sharing in the responsibility
13 of the accident investigation of Flight 587.

14 Q Did you also list under FAA certificate that
15 you have, flight time, and the aircraft that you've
16 flown?

17 A Yes, ma'am. I have flight time in everything
18 from single engine propeller aircraft -- civilian, to
19 multi-engine civilian aircraft including turbo-prop
20 aircraft with commuter airlines. I have over 2000
21 hours of fighter time in the military and I was hired
22 by American Airlines in 1986 and have flight time on
23 the Boeing 727, the McDonnell Douglas DC-9 Super 80,
24 and the Boeing 7576, The Fokker F-100, and Airbus A300,
25 and I am rated on the Airbus A310, which is the A300

1 rating.

2 Q Thank you, Captain Young.

3 QUESTIONING OF ASOK GHOSHAL

4 BY MS. WARD:

5 Q Mr. Ghoshal, would you please state your full
6 name, your current employer, and your business address?

7 A My full name is Asok Ghoshal. My current
8 employer is American Airlines, and my address is
9 American Airlines Flight Academy, DFW Airport.

10 Q What is your current position and how long
11 you've been in that position?

12 A My current position is Manager Simulator
13 Engineering, and I have been in this position since
14 1992.

15 Q And what are your duties and
16 responsibilities, and the education and training that
17 you may have received to qualify you for your position?

18 A I received my Bachelor's Degree in
19 Aeronautical Engineering in 1971 from India Institute
20 of Technology, Karapool (ph) India. I then worked for
21 two years in the aerodynamics department in Indian
22 Space Research Organization. Indian Space Research
23 Organization is somewhat like India's NASA. I came to
24 England, got my Master's Degree in Air Transport
25 Engineering from College of Aeronautics Granfield in

1 1974. I joined Link Miles, the manufacturer of flight
2 simulators. I was an engineer in the systems
3 engineering group for flight systems, while my duties
4 and responsibilities included analyzing the data that
5 came from the aircraft manufacturers, writing
6 mathematical models, and in programming them for real
7 time flight simulation.

8 In '79 I came to Link headquarters in
9 Binghamton, New York. When I left Link in 1990 I was
10 a manager of the flight group, responsible for flight,
11 autoflight, and control loading simulations for all our
12 commercial simulators. There were 34 engineers in my
13 group that time.

14 I joined American Airlines in 1990 as a
15 senior simulator engineer. In '92 I got promoted to my
16 present position. In American, our duties are to
17 insure that the simulators stay current with all the
18 changes that happen in the aircraft, both hardware and
19 software. We also assist simulator technicians as and
20 when they need added expertise in maintaining flight
21 simulators. I also am responsible for procurement of
22 any new flight simulator that American Airlines
23 purchases. I am also a member of the flight simulator
24 working group of IATA.

25 Q Thank you, Mr. Ghoshal.

1 MS. WARD: Madam Chairman, I find these
2 witnesses qualified and go ahead and turn this over by
3 Captain Dave Ivey for questioning.

4 QUESTIONING OF CAPTAIN YOUNG

5 BY CAPTAIN IVEY:

6 Q Good morning, Captain Young and Mr. Ghoshal.
7 My questioning will start with Captain Young, and just
8 as a follow on to Ms. Wards' comments, prior to
9 becoming the A-300 Fleet Training Manager, what was
10 your position?

11 A Well, I'm currently the Fleet Standards
12 Manager for the A300, and prior to that I was the F-100
13 and A300 Fleet Training Manager.

14 Q I misspoke. My apologies. And how long did
15 you hold the Fleet Training Manager position?

16 A I was a Fleet Training Manager for slightly
17 over two years, sir.

18 Q And you currently fly the A300 as well as the
19 F-100?

20 A Yes, sir, I fly both aircraft currently.

21 Q It's my understanding that you have a
22 presentation which basically follows along the first
23 line of questioning, which I'd like for you to describe
24 for me the evolution, development, and history of the
25 advanced aircraft maneuvering program, known as AAMP.

1 A Yes, sir, Captain Ivey, with your permission,
2 I'd like to go through that presentation.

3 Q That would be fine.

4 A Just a brief overview here and primarily will
5 concentrate on the AAMP program, but American operates
6 today about 819 aircraft of which 34 of those are A300
7 aircraft. We have slightly over 12,000 pilots
8 currently -- at one time much greater than that.

9 When a pilot checks out on the A300 for the
10 first time, they receive about 225 hours, just slightly
11 more, of initial training, and then they come back
12 every nine months for around 25 hours of training, of
13 which some of that is ground school, some of it is
14 simulators. The FAA, when we developed training
15 programs -- the FAA requires that the manufacturer
16 provide us with some information, and you can read
17 those out of the Part 25 there, but our training
18 programs are based, primarily, on that information, and
19 we develop our own operating manuals from those flight
20 manuals and operating manuals from the manufacturer.
21 We depend on those to develop procedures and techniques
22 to support those training programs.

23 The FAA approves our training programs and
24 they're involved throughout the entire process. They
25 monitor it on a regular basis, in fact go through

1 training themselves with us, and they do that
2 continuously.

3 The need for upset training, particularly as
4 we talk about AAMP as we call that for African
5 American, Advanced Aircraft Maneuvering Program -- the
6 industry from '87 to '96, the loss of control was the
7 leading cause of accidents, followed closely by control
8 flight into terrain, and it was very significant. As
9 the investigators, different agencies, and different
10 groups looked at those accidents, they realized that
11 some of those accidents could have been covered if the
12 pilots had known better how to respond to those upsets.

13 So, over the years, the NTSB has issued
14 multiple safety recommendations that talked about the
15 lack of training in upset recovery should -- especially
16 in transport category airplanes -- should the pilot
17 find themselves there.

18 So in 1995, what initiated our AAMP program,
19 or the AAMP as it's commonly called, the FAA issued a
20 bulletin and it recommended that airlines develop
21 training in excessive roll attitude as well as high
22 pitch attitude. And the human factors team with the
23 FAA, also in '96, issued a bulletin that stated that
24 they thought that maneuvers, especially advanced
25 maneuvers, should be integrated as part as -- integral

1 part of training programs throughout. I will note, as
2 we mentioned before, that we do depend on the
3 manufacturer to provide us procedures and techniques in
4 our operating manuals and things, and there was nothing
5 provided as far as upsets goes, or procedures.

6 So the development of AAMP. We started it in
7 1995, and over the course of about two years, we
8 developed it and we understood that there's a lot of
9 expertise out there. We never once said that we were
10 the experts in the industry, and so we tried to rely on
11 that expertise to help develop this. We wanted to be
12 the best program. The entire industry in 1995 was very
13 concerned about loss of control. There had been some
14 history of some large aircraft that had accidents, and
15 so the industry was concerned, trying to address that.

16 We also found in our AAMP program, we looked into
17 aerodynamic books, some of the widely, most recognized
18 sources to build a foundation.

19 I don't like throwing out numbers, but
20 American invested a great deal of money and effort and
21 resources to develop this program, because it was an
22 industry concern at the time, and we had -- by the time
23 that we had rolled this program out, we had already
24 spent over six million dollars presenting it to our own
25 pilots, as well check airmen instructors from lots of

1 different airlines operating around the world, as well
2 as a lot of agencies.

3 When we rolled it out, the AAMP program
4 included a full day of ground school training. We have
5 six and a half hours there because by the time of
6 breaks, and lunch, and this, that and the other, it
7 ended up being actually six and a half hours of pure
8 instruction, and then we included recurrent training
9 also, and then we have some simulator exercises.

10 We also handed out at the presentation, or at
11 the classroom, this -- this is the front cover of that
12 AAMP book, and I think we saw it yesterday with mr.
13 Hammerschmidt -- but we handed those out as a
14 supplement, a place for someone to take notes as we
15 were going through the program. It was never intended
16 to be a stand alone document. It was just to take
17 notes -- a place to take notes as we went through this
18 full day course.

19 In 1997, after we had been developing it for
20 a couple years, we had an industry conference in
21 Dallas, and we invited over 200 people from around the
22 aviation community, experts and those -- we did a two
23 day session with them, and what we did was a full day
24 of ground school, the same ground school that everyone
25 had been receiving, and then we did a half a day of

1 question and answer, and then a half a day in the
2 simulator, demonstrating the exercises that we were
3 conducting in the simulator.

4 At the industry conference, there's a -- a
5 host of attendees there, and probably most notable was
6 certainly the NTSB, the FAA, and the manufacturers --
7 Airbus, Boeing, and McDonnell Douglas, and other
8 airlines. I will state that -- and a lot of these
9 folks that were at the conference had already seen the
10 presentation before, at least once, and many of them
11 saw it afterwards too, and asked us for the
12 presentations.

13 Some of the things that came out of that,
14 some of the reviews -- I'll just -- overall reviews of
15 the program has been overwhelming, positive. And it
16 was an industry concern at the time, but one of the
17 Board members for the NTSB thought it was "one of the
18 best training experiences of any transportation mode
19 I've ever attended". Another spokesperson for the NTSB
20 said it was highly positive. The FAA applauded
21 American for taking a leadership role in the Advanced
22 Aircraft Maneuvering Program, and in fact one FAA
23 individual, the air carrier training manager at the
24 time, wanted to capture some of the material for an
25 advisory circular. NASA thought it was an outstanding

1 coverage from the pilot's point of view.

2 There's also many other airlines, and these
3 are just a few of the examples of many of the things
4 that we got. I think a notable one here was Avianca
5 there at the bottom of the page was that a pilot
6 claimed that it had helped him save his aircraft and
7 crew, and it was right after this presentation when
8 they had seen it, so -- The pilot's unions, APA as
9 well as ALPA were very fond of the presentation and the
10 course, and for American for taking the leadership
11 role.

12 Now many of the airlines -- and it wasn't
13 isolated to domestic airlines, it was also
14 international carriers -- that had asked us for a
15 program, and either utilized all or part of it to
16 develop their training programs involved in upset.
17 This wasn't just a domestic -- a US problem -- large
18 aircraft upsets. Many airlines all over the world had
19 experienced that.

20 The Flight Safety Foundation, in 2001, in
21 November of 2001, had awarded Captain Warren Vandenberg
22 -- Captain Vandenberg was responsible for oversight and
23 developing the AAMP program, and he took a leadership
24 role in that -- and the Flight Safety Foundation had
25 recognized him in 2001 for his role in the development

1 of AAMP. In that award it stated that five pilots had
2 credited AAMP for saving their aircraft and passengers.

3 As we've looked yesterday and today, there
4 was a lot of information put out about dates when and
5 when we were doing things and who was doing what, when.

6 And so I'll just highlight a couple here. We began
7 development of AAMP in 1995. The industry training aid
8 that you had heard about, started AAMP in 1996. We
9 received final approval from the FAA for our AAMP
10 program in August of 1997, and then the industry
11 training aid was presented -- yesterday I think I heard
12 August we had a letter that it was presented to us and
13 sent to us in October of 1998. So those are probably
14 the most notable dates. They're just kind of -- where
15 the industry training aid as well as AAMP was kind of
16 in development.

17 What is AAMP? And what AAMP was is it's
18 advanced training for experienced aviators involved in
19 upsets. AAMP was never a turbulence recovery training
20 unless it ended up in an upset -- that's what we were
21 specifically addressing there was upsets. Yesterday I
22 think we heard the definition, as we talked about AAMP,
23 but here's what the industry training aid says that an
24 upset is. And as you can see, it's some extreme
25 condition there, and not normal flight condition.

1 Most pilots won't ever encounter -- certainly
2 at the airlines -- will never encounter an upset in
3 their entire flying career, or we would not expect them
4 to, anyway. And from everything that we've seen,
5 Flight 587 was not in an upset until after the vertical
6 stabilizer separated from the aircraft.

7 But we did talk about wake turbulence during
8 the AAMP exercise and what did we say? We did
9 recognize the fact, and so did the industry, that some
10 situations involving wake turbulence could result in an
11 upset. The data showed that between 1983 and 1993,
12 that at least 51 accidents in the US and incidents,
13 could be attributed to some encounter -- probably
14 encounter with wake turbulence. So the FAA had issued
15 a bulletin once again, in 1994, recommending that
16 training programs incorporate heavy wake vortex
17 awareness and containment into their programs.

18 This page right here is right out of that
19 AAMP booklet that we talked about, the AAMP workbook,
20 and as you notice kind of at the bottom of the page,
21 it's got notes and that's the top half of the page. So
22 the bottom was to take your own notes -- and this was
23 more bullet statements and things -- that's what -- this
24 supplement -- that this workbook was to be used for.

25 Now what we have here, and you can read the

1 verbiage, but -- is a very, very large aircraft, MD-11
2 in this case in the picture, and a Fokker is what we
3 represented there in the roll, that a short winged
4 aircraft encountering a large aircraft wake turbulence
5 might find itself in an upset. And how do we teach to
6 respond to that?

7 Once again we're talking about very extreme
8 conditions here, not just normal upset. Thousands of
9 pilots all over the world every day fly and encounter
10 wake turbulence, that's not what we're talking about.
11 We're talking about a wake turbulence that results in
12 some extreme condition and upset. And the airplanes
13 that are really susceptible to that are airplanes with
14 shorter wing spans.

15 At the time, over 50 percent of our fleet was
16 comprised of McDonnell Douglas Super 80s as well as
17 Fokkers and they have relatively short wing spans, and
18 so they were susceptible, possibly, to an upset from an
19 encounter with wake. We never thought that larger
20 aircraft, at the time the DC-10, the MD-11, 757, 76,
21 the A300, would end up in an upset just from a normal
22 encounter with wake turbulence. Once again, we're
23 talking about when it resulted in extreme things like
24 i.e., 90 degrees of bank, once again, in an upset.

25 What we taught was that if you find yourself

1 in an upset, apply the appropriate procedure -- the
2 upset procedure. And the only time we really talked
3 about using rudder was when we were using high AOA
4 maneuvering, and I'm sure we'll get to that later in
5 our questioning.

6 So what did we teach in AAMP about rudder?
7 We taught that ailerons/spoilers are primary roll
8 controls, and that's intuitive to every pilot from the
9 beginning, when you first start flying. And I have a
10 video here -- the significance of the video, and I
11 think Mr. Brenner brought it out yesterday, that this
12 film was actually filmed in 1997, in the March-April
13 time frame of 1997. These are actual film clips from a
14 class. We didn't have it set up in a studio. It was
15 filmed in a classroom environment and there was
16 somewhere over 200 students at the classes, and this is
17 the actual presentation.

18 (Audio from video presentation:)

19 "The next thing then, says, roll. Well,
20 since you've unloaded what are you going to roll with?
21 Well, you're going to roll with ailerons and spoilers
22 aren't you? The rudder won't roll this plane rolling
23 on ... the back. Ailerons and spoilers roll it. 90
24 degrees of bank, nose low. Looks like this. Well,
25 this is where the neutral part comes. Neutral. You're

1 going to unload toward about zero G, "neutral". About
2 zero G. Then, back to bullet one. Roll the shortest
3 direction towards the sky pointer. What are we rolling
4 with? We're rolling with yoke, with ailerons and
5 spoilers because we have no alpha on this plane.

6 "And since we're rolling full forward on the
7 yoke, we've actually got a negative alpha on this
8 airplane right now, but that's what's going to roll the
9 plane, it's going to be yoke. The ailerons and
10 spoilers. So as we hold full forward, we roll the
11 yoke, and which way? Back to bullet one, we roll
12 towards the sky pointer. So we're rolling full
13 forward, and we're rolling towards the sky pointer."

14 There was mention of the industry training
15 aid yesterday, and so there's a slight comparison here.

16 I wanted to compare the industry training aid with
17 what we were teaching in AAMP, and they were basically
18 in development about the same time, although AAMP was
19 out in front, there was some crossover there. AAMP
20 taught that the primary roll controls, which you just
21 saw from the film clip, they're effectiveness decreased
22 with increased angle of attack. And the industry
23 training aid stated that ailerons and spoilers become
24 less effective -- and talking about high angle of
25 attack there.

1 We also stated that -- in AAMP -- that at
2 high angles of tack, the rudder becomes an effective
3 roll control, and the industry training aid talked
4 about ailerons and spoilers, if they're ineffective,
5 then rudder inputs may be required.

6 We also talked in AAMP that rudders should
7 only be used in coordination with other roll controls,
8 and you can see there that we had some cautions about
9 it, that it must be applied smoothly, and that, once
10 again, I have a video clip, and that's from 1997, as we
11 stated, in a classroom environment.

12 (Audio from video presentation:)

13 "Bullet number four has a whole bunch of
14 nuances in it. It says, 'As the aircraft symbol
15 approaches the horizon' -- well, that's the issue we
16 just talked about, you've got to lead the roll. You've
17 got to lead the roll out in order to get the lift
18 vector up in time. Then it says, 'Make a coordinated
19 roll' -- and I have that word coordinated underlined,
20 and the reason that I do is because I want to get it
21 straight between us today what I mean by that.
22 Because, rightfully, there's a lot of different
23 meanings for that word out there. But in everything we
24 do today, when I say coordinated rudder, what I mean is
25 that we will apply rudder in the direction we are

1 trying to roll the plane. Left rudder, left roll; right
2 rudder, right roll. And just the amount of rudder that it
3 takes to get the desired roll response. And these are very
4 powerful rudders. It might take smooth, small applications
5 to get the desired results in most of our fleet."

6 The industry training aid talked about that
7 coordinated use of rudder may be required, and it said
8 that in more than one place.

9 Also, AAMP talked that the rudder was a very
10 powerful control and it can generate excessive side
11 slip -- it can generate side slip and lead to loss of
12 control.

13 (Audio from video presentation:)

14 "The next thing then says, roll. Well, since
15 you've unloaded, what are you going to roll with?
16 Well, you're going to roll with ailerons and spoilers,
17 aren't you. The rudder won't roll this plane at
18 rolling ... the back, the ailerons and spoilers roll
19 it. So we come in with ailerons and spoilers and we
20 roll towards the nearest horizon, i.e, if you're right
21 wing low, roll right.

22 "Now some of you out there might say, well,
23 I'm going to use a roll coordinated rudder to help the
24 nose come down. Fine. That's fine. That's good
25 technique. A little, smoothly applied. I mean

1 understand right here, if you jam full right rudder,
2 that's the spin entry procedure.

3 "To complete this unusual attitude recovery
4 procedure segment of the Advanced Aircraft Maneuvering
5 Program, I'd like to briefly review the proper use of
6 rudder at high angles of attack. As I stated in the
7 aerodynamics segment, smooth application of small
8 amounts of rudder, coordinated with the aileron will
9 significantly improve the roll response at high angles
10 of attack.

11 "I'd like to reemphasize that we have very
12 large, powerful rudders on our aircraft. We do not
13 want to introduce high side slip angles with high
14 angles of attack by either kicking the rudder or
15 applying the rudder in excess at high alpha. It only
16 requires a small amount of smoothly applied,
17 coordinated rudder to achieve the desired results.
18 This coordinated rudder will significantly improve the
19 roll response at high angles of attack."

20 Note the little tag there at the end, that
21 was in response to a feedback letter that we've
22 received from four signatories that had attended this
23 conference, and we put that on the end of the tape in
24 1997, and sent that out to each and every American
25 Airlines pilot. But the industry training aid talked

1 about the rudder being very powerful, the same thing
2 that we were saying in the AAMP.

3 And we talked about that use of returning the
4 aircraft to proper attitude, that it might take the use
5 of rudder, and we talked about some cautions there, but
6 in coordination with the ailerons and spoilers, full
7 speed recovery and preserve altitude. And the industry
8 training aid, it spoke specifically of primary flight
9 controls as being ailerons, elevator and rudder.

10 In the industry training aid, they also
11 talked about -- and I think this is very notable --
12 talked about pilots must be prepared to use full
13 control authority when necessary. The tendency is for
14 pilots not to use full control authority because they
15 are rarely required to do this.

16 There's been a lot of talk about the
17 simulators and some questions yesterday involved
18 simulators and what we taught in AAMP. We had two
19 upsets that we performed in the simulators in relation
20 to AAMP exercises. And we did one, an uncommanded roll
21 to at least 90 degrees. A bulletin that had come out
22 that initiated a lot of this talk about upset recovery
23 training from the FAA, the 9510 HBAT, recommended
24 uncommanded roll in events of at least 90 degrees. The
25 industry training aid recommended at least 120 degrees

1 of bank angle with 20 degrees nose low.

2 We also had a pitch, an uncommanded pitch
3 exercise between 20 and 40 degrees. Once again, the
4 bulletin, the HBAAT 9510 recommended a nose high event
5 of at least 35 degrees, and the industry training aid
6 recommended an exercise in at least 40 degrees.

7 We understand there's some simulator
8 limitations. We never once suggested that the
9 simulator is exactly 100 percent perfectly replicate an
10 airplane, but they're the best tools that we have
11 available. The industry was concerned about upsets at
12 the time, and we were trying to use the best training
13 aids and the best tools we had available to teach this,
14 and the FAA agreed with us on that.

15 The NTSB has sent out several safety
16 recommendations and so it was a concern, and our
17 objective in AAMP was clearly, pilot recognition to try
18 and avert an upset condition, but if you found yourself
19 in an upset condition, to apply the proper and correct
20 procedures to recover from that upset. We know that
21 the fidelity of the aircraft was not perfect, but we
22 thought there was something to be gained. There had
23 been accidents where we had talked about, or we had
24 investigated and once the crew got beyond 90 degrees
25 that they had failed to push on the yoke to help

1 preserve altitude, and in fact, they had actually
2 pulled and decreased their chances of recovery. So
3 although the simulator can't replicate negative G, we
4 think there's some value to be learned from learning
5 and systematically learning to push instead of pull and
6 help yourself to recovery.

7 Yesterday we talked about full stall
8 exercise. Captain Rockliff mentioned that. The
9 simulators did not replicate that, and we took their
10 advice, and we listened to them, and we didn't
11 incorporate full stall series into our simulator
12 exercises. We do approach to stalls, but we do not do
13 full stalls for that very reason. We understand
14 there's some fidelity issues with that.

15 We also invited the manufacturers to come and
16 look at our packages and what the exercises we were
17 doing in AAMP.

18 Yesterday, the Tenth Performance Conference
19 came up and -- in September of 1998, Airbus conducted
20 the Tenth Performance Conference, and Captain
21 Wainwright from Airbus had written a letter. Quite
22 frankly, we were a little surprised at some of the
23 comments, and it's included in the Exhibit list on this
24 particular accident, and so that's why I address it
25 here, because we don't think it reflected what we were

1 teaching in AAMP.

2 These are just a few examples that we just
3 ran through, and I won't belabor the point, but we
4 talked about thrust effects on under wing mounted
5 engines were ignored -- and speaking of the airlines
6 there -- and talked about -- Captain Wainwright talked
7 that had a significant influence on recovery. And this
8 is a page, again, out of that supplemental work book,
9 and also Captain Vandenberg during his presentation at
10 ground school, talked about it. But we clearly talked
11 about the thrust effect, and specifically we talked 7-
12 5, 7-6, and the A300 had a powerful moment to pitch
13 axis.

14 At the Tenth Conference Airbus also stated
15 that training that was already being done considered
16 upsets as being due to momentary inattention to fully
17 serviceable aircraft, that was in trim when it was
18 upset. And once again, here's a page out of that
19 workbook, and this is just a bullet statement to an
20 instruction that Captain Vandenberg was talking about
21 during that time, so clearly, we did talk about that.

22 It also talked about emphasizing excessive
23 nose pitch up attitudes, emphasizing rapidly
24 Rolling to 90 degrees of bank, and in fact we never
25 taught that. Once again, here's a video clip from

1 1997.

2 (Audio from video presentation:)

3 "We've got this next bullet that says
4 normally limit banking to approximately 70 degrees. I
5 hate a number. Whenever I put a number up, a pilot
6 sees a target. So listen, that's not a target. It's
7 kind of a limit. What am I saying there? Well, as I
8 started doing this in our larger transport airplanes, I
9 initially reverted to my other life. In my other life,
10 you know, I just rolled the 90 degrees of bank and just
11 came on down. Well, when I did that in the big
12 transport simulators, I learned something kind of
13 surprising, that shouldn't have been, but it was. When
14 you come to the horizon with 90 degrees of bank on
15 these big puppies, you don't have adequate roll rate to
16 get the lift vector pointed back up before you end up with
17 a nose way down here. Now you have to do one of those
18 nose low recoveries, see. You know, you can't -- the
19 good news is you can get them both done on the same
20 maneuver. But it's not ideal. We really don't want
21 that to happen. So the reason that 70 degree bullet is
22 in there is to say in these big guys, we've got to
23 keep our lift vector up a little bit as we approach the
24 horizon, so we don't have so far to go with it, to get
25 it turned up the rest of the way because of our roll

1 rate.

2 "The other way of looking at that -- because
3 I want to kind of get this clear -- is you don't need
4 to go to 70 degrees of bank, that's not what I'm
5 saying. If you're at a 45 degrees climb, then maybe
6 you only need 45 degrees of bank, and that'll be
7 enough, see. But don't go to the horizon like this in
8 these guys, it doesn't work."

9 Okay, and I will add that you saw the 70
10 degrees in there. After the industry training aid came
11 out, they had recommended 60 degrees, and we
12 subsequently changed that and updated that.

13 At the Airbus conference, it was always
14 stated that the training managers were all in the habit
15 of demonstrating the handling characteristics beyond
16 the stall. And as I mentioned before, we didn't teach
17 full stalls in the simulators, as a result of that, and
18 here's a film clip.

19 (Audio from video presentation:)

20 "In conclusion, let me reinforce that AAMP
21 emphasizes keeping the aircraft inside its flight
22 envelope at all times, regardless of attitude.
23 Likewise, in your simulator training, you should never
24 increase the angle of attack above the onset of
25 stickshaker alpha -- that angle of attack that we know

1 as CL-max."

2 And we also had a page in the workbook that
3 stated that we did not do full stalls, as you can see
4 here. So we clearly addressed that issue.

5 One of the things that was stated there was
6 that airlines were accustomed to teaching, and through
7 their backgrounds, fighter pilot background or
8 whatever, that we were accustomed to teaching scissors-
9 type maneuvers. And clearly we never talked about
10 doing scissor-type maneuvers of anything. Through the
11 film clips so far, you can recognize that we never
12 talked about that, and we always talked about
13 exercising caution when using the rudder, and
14 particular with small, appropriate amounts.

15 Once we held the industry conference in 1997,
16 our Vice President of Flight had requested feedback
17 from every attendee there and specifically, the
18 aircraft manufacturers and the FAA. We solicited their
19 input and feedback, once again recognizing that we were
20 not the only experts out there in the industry in this,
21 and we wanted to draw on that expertise that was other
22 places.

23 Now, the August letter that came to us was
24 from Airbus, Boeing, McDonnell Douglas and the FAA, had
25 some things in it that -- I'll just bring up a few

1 examples here I wanted to correct. But it says
2 "Although the simple rule about rudder usage cannot be
3 stated, a more appropriate standard is to first use
4 aileron control. If the airplane is not responding use
5 rudder as necessary to obtain the desired airplane
6 response." Here's a video clip once again, from 1997.

7 (Audio from video presentation:)

8 "Well, as highly experienced aviators, I want
9 you to think about this with me. I'm going to suggest
10 to you that as we're out there flying along in our
11 airplanes somewhere, someplace -- could be anywhere --
12 let's say flying somewhere entering the traffic pattern
13 of the approach or whatever, our airplane starts to
14 roll. I'm going to submit to you that I, for myself,
15 and I think if you think about this too, at this
16 instant, probably don't have any idea why it started to
17 roll. I mean it could be rolling because as I
18 configure my flaps and slats went asymmetric. It could
19 be rolling because I hit the vortex of the guy ahead of
20 me. It could be rolling because of an engine failure.

21 At this instant, I doubt I'm smart enough in most
22 situations, and certainly in the weather, to understand
23 clearly at this point, why it's rolling. All I know is
24 it started to roll. It's an uncommanded roll. My job
25 is to stop it. Right.

1 "So I come up with some yoke and say, come
2 on, stop rolling. But it doesn't. So I come up with
3 some more yoke and say, come on, stop rolling. And it
4 doesn't. Well, what control would I go to now if this
5 isn't stopping a roll. Yes. Rudder, sure. So I come
6 in now with coordinated rudder, right rudder in this
7 case, trying to roll right."

8 So clearly that demonstrated that we talk
9 specifically about if the aircraft was not responding
10 to aileron and spoiler control, that you use smooth
11 application of coordinated rudder.

12 Now after we sent our response, our Vice
13 President of Flight sent a response letter back to that
14 feedback letter from August of 1997, we didn't receive
15 any response back from any of the signatories, once
16 Captain Muell (ph) had responded to that, and in fact,
17 one of the signatories later on advised Japan Airlines
18 to contact us to get our program, our AAMP program.

19 We also, and you saw in one of the video
20 clips there, where we had added a section at the very
21 end of the video to reinforce the proper use of rudder,
22 and that was sent out to each and every American
23 Airlines pilot in 1997, December of 1997. And that
24 tag, it repeated warnings about how powerful the rudder
25 could be. It reiterated the fact that rudder generated

1 side slips could lead to loss of control, and it
2 reemphasized the fact that rudder must be applied in
3 smooth, appropriate amounts.

4 In addition, we clarified some of our written
5 materials and the workbook in particular, that what was
6 already being taught, but sometimes the bullets may
7 have been misworded or whatever, so we clarified. And
8 example would be down there, as you see, on the right
9 side there, where it says high AOA equals coordinated
10 rudder. On the left side it had said high AOA
11 maneuvering equals rudder. And we just -- we used that
12 feedback letter to clarify some of our statements in
13 our written materials there.

14 I know I've talked for a little while here,
15 and I don't mean to belabor the point, so I'll just try
16 to bring three of them home to you. We haven't seen
17 anything in the 587 accident to indicate that it was an
18 upset. It was not an upset until after the vertical
19 fin separated from the aircraft.

20 Pilots all over the world encounter wake
21 turbulence daily. That's not what we're talking about
22 here in AAMP. AAMP was one of the most widely
23 reviewed, and widely applauded training programs in
24 aviation history. At the time, there was a great and
25 genuine concern about loss of control of large

1 aircraft, in particular, transport category aircraft,
2 and we, as an industry, not American Airlines alone,
3 but we as an industry, were trying to address that
4 concern and prevent it from ever happening again. And
5 AAMP always taught for the pilots to respect the power
6 of the rudder.

7 And once again, here's a little small video
8 clip, and this was from December of 1997, this little
9 tag that we sent to all of our pilots.

10 (Audio from video presentation:)

11 "To complete this unusual attitude recovery
12 procedure segment of the advanced aircraft
13 maneuvering program, I'd like to briefly review the
14 proper use of rudder at high angles of attack. As I
15 stated in the aerodynamics segment, smooth application
16 of small amounts of rudder, coordinated with the
17 aileron will significantly improve the roll response at
18 high angles of attack.

19 "I'd like to emphasize that we have very
20 large, powerful rudders on our aircraft. We do not
21 want to introduce high side slip angles at high angles
22 of attack, by either kicking the rudder or applying the
23 rudder in excess at high alpha. It only requires a
24 small amount, smoothly applied for a coordinated rudder
25 to achieve the desired result. This coordinated rudder

1 will significantly improve the roll response at high
2 angles of attack."

3 And that concludes my presentation, sir.

4 Q Thank you, Captain Young. Just a couple of
5 questions that relate to the presentation that you
6 made.

7 A Yes, sir.

8 Q You stated in the presentation that American
9 invited Boeing, McDonnell Douglas and Airbus to review
10 the AAMP simulator data.

11 A Yes, sir.

12 Q Did any of those organizations accept your
13 invitation?

14 A Not to my knowledge.

15 Q And so no one reviewed your simulator data to
16 either add or subtract or modify what you had at that
17 time?

18 A Of the aircraft manufacturers?

19 Q Yes.

20 A There was dialogue between the manufacturers
21 at the time, and I -- I don't know whether they
22 modified the simulator data or not, sir.

23 Q And one other comment, just for the audience
24 and everyone here. You mentioned in the presentation a
25 scissors maneuver. Would you mind describing what

1 scissors maneuver is?

2 A Only through previous experience do I know
3 what that word means, through being a fighter pilot,
4 but a scissors maneuver was a maneuver where you had
5 two aircraft that were fighting each other, and would
6 find themselves in very close proximity, trying to
7 outrate each other -- trying to outrate each other, and you
8 could get into what we call a scissors maneuver. That was
9 very extreme, very specific to fighter aircraft only.

10 Q And lastly, regarding the presentation, it stated
11 that American was aware of simulator limitations and
12 encouraged Airbus to review the alpha and beta angles
13 generated by the AAMP maneuvers. Did that ever occur?

14 A Not to my knowledge, sir.

15 Q Regarding the AAMP program, were there any major
16 changes made to the program since the inception of AAMP?

17 A At the very inception, -- the changes that were
18 made, the ground school was extended. Initially it started
19 out as -- it was planned to be four hours, and we realized
20 once we got into it, the foundation of which you build for
21 this particular maneuver, upsets, that the foundation wasn't
22 there, and so we had to extend it to a full day of ground
23 school. So that changed, and there's been modifications to
24 it all along the line, so I'm not sure if you'd consider
25 those major or not.

1 Q Is the AAMP program generic, or is it specific to
2 airplanes in the American fleet?

3 A The AAMP program itself is generic. The ground
4 school is very generic, but each and every fleet has some
5 specifics that apply to their particular aircraft, and they
6 address those in the ground school as well as the simulator
7 training.

8 Q Have you had the opportunity to compare the AAMP
9 program, in particular the A300 program, to other airlines
10 that operate similar sized airplanes, or A300 airplanes?

11 A Yes, sir, I have, actually.

12 Q And would you mind commenting on how your program
13 compares with other airlines programs?

14 A As I reviewed the other airline programs, and
15 primarily I stayed with domestic air carriers here in the
16 US, but as I looked at their programs, I would say that some
17 programs appear to be more aggressive in some of the
18 maneuvers they conducted in the simulators in some of their
19 training, and some programs were as little as point and
20 click off a computer, and multiple choice. So, when you
21 look at the airlines, there really didn't seem to be a
22 standard for the AAMP or upset training, and if I had to
23 guess, I would say we were -- I don't know if we were in the
24 middle of the road, but we certainly use simulators with
25 motion to train.

1 Q Just based on what you just said, is it all over
2 the place? Some use simulators, some don't use anything but
3 classroom? Some use interactive TV screens, computer based
4 training?

5 A I think that's a correct statement from what I've
6 seen, yes, sir.

7 Q So the industry training aid was being developed
8 as your AAMP program was being developed, and my question to
9 you is, did the AAMP program incorporate many of the
10 features of the industry training aid, and/or did the
11 industry training aid incorporate many of the features of
12 the AAMP? Was it a combination of both or did it go more or
13 less one way or the other?

14 A I don't know if we can state it went one way or
15 the other. As you look at the industry training aid, it has
16 very, very similar characteristics to the AAMP program. Now
17 the AAMP program started development about a year prior to
18 the industry training aid starting it's development. We did
19 incorporate some changes to our AAMP but I mentioned where
20 we changed them from 70 degrees to 60 degrees but the ITA
21 had recommended 60 so we updated our program after the ita
22 came out. The ITA seems very reflective of the AAMP
23 program.

24 Q In your review of the AAMP program, did Airbus
25 Industries provide any guidance to American

1 concerning the AAMP program as it related to the A300?

2 A Outside of the industry training aid, we
3 never really received anything from airbus concerning
4 upsets.

5 Q You certainly are familiar with the FCOM, the
6 Flight Crew Operating Manual.

7 A Yes, sir, I am.

8 Q Is there any guidance in that manual that
9 relates to upset training or wake turbulence encounters
10 in the A300?

11 A After the 587 accident, we received a
12 bulletin from Airbus and it incorporated some, not
13 procedures, but it incorporated some guidelines or
14 techniques that addressed recoveries. But prior to
15 that, no, sir.

16 Q And so Airbus never incorporated any FCOM
17 procedures into their manual, based on what you just
18 said that might have been discussed in the industry
19 training aid.

20 A Not to my knowledge. I don't want to give
21 you the wrong impression here that -- there was
22 dialogue between the airlines and the manufacturers, so
23 -- but in the formal written communication or specific
24 upset procedure in the FCOM, no there was not.

25 Q And you just testified about receiving

1 something post-accident from Airbus.

2 A Yes, sir.

3 Q And do you recall what information that was
4 about?

5 A The information that came to us from Airbus
6 for the operating manual, was a bulletin that spoke
7 about some of the concerns that came out of 587,
8 upsets, and it talked about rudder usage, et cetera.
9 And that was after a response to a safety
10 recommendation from the NTSB.

11 Q Have there been any changes since the
12 accident made to the AAMP program by American Airlines?

13 A Yes, there has. Well, what we've done is
14 once this accident happened and as I stated, that
15 normal encounter with wake turbulence, we did not
16 expect that to be AAMP unless it resulted in an upset
17 of some type. But there were certainly some questions
18 coming to us about our AAMP program and our training,
19 and we're committed to making sure this never happens
20 again, and we have been reviewing our AAMP training
21 program and the changes that we made so far, and it's
22 still under review, is that we had some preprogram
23 simulator buttons in the simulator to address rolling
24 maneuver and a pitch maneuver. And we removed those
25 preprogrammed buttons from the instructor, but other

1 than that, AAMP has remained basically the same.

2 Q Well, thank you because you led very aptly to
3 my next question -- and this may be in Mr. Ghoshal's
4 area -- would you mind describing how a pilot was
5 placed into an unusual attitude in the A300 simulator?

6 A I can, and then I'll hand it over to Mr.
7 Ghoshal. The instructor in the simulator has a panel
8 just behind the two pilot seats, and they would go to a
9 page on the computer screen there, and they would
10 select either pitch maneuver or roll maneuver, and that
11 would put them into an upset condition. So the
12 specifics of that upset, Mr. Ghoshal can address.

13 QUESTIONING OF MR. GHOSHAL

14 BY CAPTAIN IVEY:

15 Q Okay.

16 A Yes, Captain Ivey, I have a small
17 presentation I would like to make that might explain
18 how the simulator works and how we do these upsetting
19 maneuvers in the simulator. Is that okay?

20 CAPTAIN IVEY: That would be fine.

21 MR. GHOSHAL: This particular presentation is
22 about how the software programs are modified in
23 American Airlines flight simulators in support of our
24 AAMP program. American initially started with two
25 upset events. One was upset rolling event, and the

1 other one, upset pitching event. And I would like to
2 briefly describe what the upset rolling event was.

3 In the upset rolling event the simulators
4 simulates a significant rolling moment that overpowers
5 the crew's control authority and rolls the aircraft
6 past 90 degrees. This upset rolling event was not
7 intended to simulate an encounter with turbulence from
8 which either the recovery was routine, or one that
9 could be arrested before the aircraft was in upset.

10 The simulation was intended to replicate a
11 significant uncommon dead roll event from an unknown
12 source. It could be an engine problem. It could have
13 been a flight control malfunction, or even some air
14 mass anomalies. It would probably be helpful at this
15 stage to explain in a sentence or two how the flight
16 simulator works. A flight simulator uses computers
17 where we solve complex mathematical equations that
18 presents the different systems and subsystems to
19 replicate actually how the aircraft flies.

20 Now let me explain how the actual simulator
21 was programmed in support of the upset rolling event.
22 First, a rolling moment is induced, as Captain Young
23 said, the instructor presses a button and this is what
24 happens in the background. First a rolling moment is
25 induced to roll the aircraft in one direction,

1 approximately ten degrees. The direction it rolls is
2 random. Second, a rolling moment is then induced to
3 roll the aircraft in the opposite direction past 90
4 degrees. For example, if the aircraft rolled first
5 right wing down ten degrees, it will now roll left wing
6 down 90 degrees. The aileron, the spoiler, and the
7 rudders are ineffective until the aircraft reaches a
8 bank angle of 50 degrees, or maximum of ten seconds.

9 After the aircraft reaches the bank angle of
10 approximately 50 degrees, the yaw and the roll control
11 are phased back in over the next 1.3 seconds. The
12 phasing in of the control authority in the next 1.3
13 seconds, and the moment of the aircraft is what takes
14 the aircraft past 90 degrees. The roll rate after
15 approximately 50 degrees, and the final bank angle
16 depends on how effectively the pilot responds. The
17 software changes that we made in the flight simulators
18 do not favor the rudder over ailerons. The pilot can
19 recover from the upset without using the rudder.

20 Now let me discuss how the upset pitching
21 event was. The upset pitching event was an event that
22 simulates a pitch up of the aircraft between 20 and 40
23 degrees nose up. This simulation was again intended to
24 replicate a significant pitch up event from an unknown
25 source.

1 I'll now explain how the software programming
2 was done. First a pitching moment is induced to drive
3 the aircraft pitch angle to 37 degrees minus half the
4 roll angle. During the time, the horizontal stabilizer
5 is driven up, the elevator and the horizontal
6 stabilizer are ineffective until the aircraft reaches
7 the final pitch angle or maximum 11 seconds. Pitch
8 control authorities then phase back in over the next
9 1.3 seconds. The final pitch angle of the aircraft
10 depends how effectively the pilot responds. The
11 software changes that we made in the simulator do not
12 favor rudder over ailerons. The pilot can recover from
13 the upset pitching event without using any rudder.

14 A common issue, when you talk about flight
15 simulators is a simulator's fidelity. In laymen's
16 terms, simulator fidelity merely means how the
17 simulator replicates the flying aircraft. To
18 accomplish this goal, we have physically a cockpit with
19 instruments, seats and the pilot, along with powerful
20 computers in which we run the software for the actual
21 aircraft.

22 Simulators are built by manufacturers like
23 Link, the company I used to work for, CAE, but these
24 simulator manufacturers, however, do not create the
25 mathematical models or the data that are used in the

1 flight simulator to recreate the flight. Those come
2 from aircraft manufacturers. Consequently, in the
3 airplane upset recovery training aid which are referred
4 to the industry training aid has it right when it
5 states, "simulator fidelity relies on mathematical
6 models and data provided by airplane manufacturer."

7 The industry training aid contains a number
8 of recommended training exercises for using the flight
9 simulator. According to the industry training aid,
10 these exercises are designed to keep the simulator
11 within the mathematical models and data provided by
12 airplane manufacturers. From a aerodynamics modeling
13 point of view, there are two key parameters to consider
14 here as to how an aircraft flies. This is angle of
15 attack, alpha, and angle of side slip, the beta.
16 Although it may not be intuitive, the actual pitch
17 angle, roll angle, and the heading angle are not that
18 important. The industry training aid recognizes that
19 the angle of attack and side slip angle are the key
20 factors when it cautions us to "Ensure that the
21 combination of the angle of attack and side slip angle
22 reached in the maneuver shown in the flight simulator
23 do not exceed the range of the validated data or
24 analytical extrapolated data supported by the airplane
25 manufacturer."

1 What you are looking at now is an alpha-beta
2 block. This chart was provided by Airbus for industry
3 training aid. The vertical axis here is the angle of
4 attack, alpha, the horizontal axis is angle of side
5 slip, beta. There are three types of data in this
6 chart. Right in the center is something called flight
7 data, surrounded by wind tunnel analytical data, and
8 then the data extrapolated for the simulator used by
9 Airbus engineers.

10 However, when this aircraft manufacturer
11 provides this data to the simulator manufacturer or to
12 an airline, these data is not separated into this neat,
13 three boxes. Instead, the variable that the data
14 tables that the Airbus provides for building a flight
15 simulator, do not make any difference among the three
16 types of data. As an aerodynamics engineer, however,
17 providing all the variables in the same table is not a
18 problem, as we saw from the highly accord (ph) from the
19 industry training aid says, "As long as the flight
20 simulator is using any of these three types of data,
21 the simulator should be accurate in presenting how the
22 real aircraft will fly."

23 The industry training aid actually agrees.
24 It explains that the key to consider here is angle of
25 attack and side slip angle, even if the airplane is

1 flying upside down. It says, "For example, a full 360
2 degree roll maneuver conducted without exceeding the
3 value range of angle of attack and side slip angle,
4 will be correctly replicated from an aerodynamic
5 standpoint." In other words, even when the aircraft
6 has rolled 180 degree, i.e., the aircraft is upside
7 down, it is still the angle of attack and side slip
8 angle, and not this 180 degrees of roll angle, that
9 determines how accurately the simulator represents the
10 aircraft from an aerodynamic standpoint.

11 This point can be further illustrated in the
12 industry training aid by looking at some of the
13 training exercises it recommends. For example,
14 industry training aid includes a recommended exercise
15 for a nose high event of at least 40 degrees. A higher
16 pitch angle than the one would reach during the AAMP pitch
17 maneuver. It also includes an exercise for a rolling
18 event with 120 degrees bank angle and 20 degrees nose
19 low. Again, a greater bank angle than the one
20 reached during the AAMP rolling event, along with a
21 much lower pitch angle while inverted. But, as I
22 stated earlier, angle of attack and angle of side slip
23 are the key factors, not the pitch angle or the roll
24 angles. The angle of attack and side slip during AAMP
25 exercises are similar to those in the industry training

1 aid exercises.

2 In conclusion, first, side slip and angle of
3 attack were monitored during AAMP exercises when we
4 developed it; second, each AAMP exercise in the rolling
5 and the pitching event, was flown and evaluated in
6 each simulator type before being rolled out to other
7 simulators of the same type; third, the AAMP pitch
8 maneuvers and roll maneuvers stay within the valid
9 data; fourth, these were not major changes to the
10 simulators; fifth, the aerodynamic coefficient data
11 tables provided by the aircraft manufacturer for the
12 simulators used, were not changed; and finally, as
13 Captain Young told you, both domestically and
14 internationally, the AAMP program was widely applauded
15 and other carriers and training centers, not only
16 requested the data for the ground school, but they also
17 requested the software changes and implemented
18 simulator changes to their simulators. Thank you for
19 your time.

20 MR. IVEY: Thank you, Mr. Ghoshal.

21 FURTHER QUESTIONING OF CAPTAIN YOUNG

22 BY CAPTAIN IVEY:

23 Q Captain Young, you've been in the simulator,
24 and I'd like to ask you if you think the simulator
25 adequately represents the airplane.

1 A Specifically to the AAMP maneuvers, is that
2 what you're speaking to?

3 Q Yes, sir.

4 A Well, I've never been in an upset in a large
5 aircraft before, so I can't speak to that directly, but
6 what I do know is that when pilots go into simulators,
7 I mean we know right away that, although simulators are
8 the best tool available and they're wonderful machines,
9 they are not an exact replication of the airplane. But
10 as it pertains to this AAMP maneuvers, we never really
11 stated that it was an exact replication of the
12 airplane. We were working more with procedures and how
13 to recover should you find yourself in that position.
14 So I don't know if that answers your question or not.

15 Q It does, and I think based on that answer, do
16 you still believe that a simulator provides an adequate
17 means of training to recognize and to recover an upset
18 training as opposed to using computer based training or
19 ground school presentation outside the simulator?

20 A I do because I think there's some value. As
21 you look around, I don't know of a better training aid,
22 shall we say, to teach some things. And through the
23 accident history there have been some very definite
24 trends in the mid-nineties that the industry was trying
25 to address with accidents as a result of loss of

1 control. And we think it's far more important that
2 just to read out of a book. We're not for sure you
3 gain the skills necessary to recover from an upset from
4 just reading it out of a book, and so we think that the
5 simulator is the best tool available for training those
6 skills.

7 CAPTAIN IVEY: And Mr. Ghoshal, you stated
8 that the manufacturer had provided a data package and
9 there had been no changes since the original submission
10 to you, is that correct?

11 MR. GHOSHAL: Yes, sir.

12 CAPTAIN IVEY: So since the accident, there's
13 been no changes in terms of data or modification to the
14 information?

15 MR. GHOSHAL: Yes, sir.

16 CAPTAIN IVEY: Has the FAA required or
17 requested any additional changes since the accident?

18 MR. GHOSHAL: Not for any simulator software.

19 CAPTAIN IVEY: I don't know who might answer
20 this question, but is there any simulator recording of
21 data accomplished either during a student going through
22 the program of upset recovery, either to observe
23 simulator activity or the individual pilot's recorded
24 control inputs, either for modifications to simulator,
25 or for debriefing to the pilot upon concluding the

1 simulator period?

2 CAPTAIN YOUNG: Maybe that might be a
3 question for myself. The instructor -- we don't record
4 any data during the upset recovery maneuver, and
5 there's nothing presented to the student, nor the
6 instructor pilot.

7 CAPTAIN IVEY: Is there a means or a way in
8 which the G loads, since it is a simulator and you
9 can't replicate the G loads that would be in an
10 airplane either positive G or side lift, is there any
11 recorded information related to G loads which can
12 either be debriefed with the pilot or looked at for
13 comparison as to how they're being generated by the
14 student?

15 CAPTAIN YOUNG: I'll answer the first part,
16 and then I think maybe some of it applies to Mr.
17 Ghoshal, but the first part, in positive and negative
18 G, certainly a positive G, the simulator, if you exceed
19 some parameter, it will crash, so if you exceed that
20 parameter, you would get a crash possibly on the
21 simulator, but as far as lateral or negative G excedence
22 parameters -- and I don't know what these numbers are,
23 but you can knock it off of motion, and then it will
24 settle down off of motion, and you have to reset the
25 motion on it. Maybe Mr. Ghoshal can speak to the

1 parameters.

2 MR. GHOSHAL: As far as the vertical load
3 factor goes, yes, you can -- it is a variable in the
4 simulator, it can be shown or recorded, same as the
5 side slip angle, it can be recorded. We do not have
6 the simulation for side loads, and we do not -- the
7 simulator data doesn't show what side loading might do
8 structural damage or something, if that's what you are
9 asking, sir.

10 BY CAPTAIN IVEY:

11 Q Earlier I'd asked questions pertaining to the
12 modifications in the AAMP program, have there been any
13 modifications to the ground school portion of the AAMP
14 program since the accident?

15 A Well, there has. We have spent a great
16 effort after the accident, after 587, Flight 587
17 accident of teaching our folks about maneuvering speed
18 and what that means and what they thought about before
19 that. Also rudder limiter system, and the sensitivity
20 of the pedal -- rudder pedal, as well as the
21 restrictive movement or limited displacement of the
22 rudder pedals. So that's a good time to talk about it
23 is during our AAMP discussions because it talks about
24 aircraft maneuvering. So I guess that was a change.
25 The basic, core program, though, has not changed.

1 Q Regarding the AAMP booklet that was shown on
2 the screen and Member Hammerschmidt displayed
3 yesterday, is that still being used and distributed?

4 A As of right now, and I do have to qualify
5 this, that we're not in a position of expanding and
6 hiring pilots right now. That full day ground school
7 and that workbook is given out during that initial
8 ground school for AAMP. We don't hand it out for
9 recurrent. That's a one time supplement material, and
10 so we haven't conducted a full ground school of AAMP in
11 a long time, other than to review it recently.

12 Q If today good fortune were to allow you to
13 have a new hire class, would that booklet be used
14 today?

15 A To my knowledge, yes, sir.

16 Q And I'd like to talk about a few of the terms
17 that you just brought up. For example, the rudder
18 limiter systems. How much, in your opinion, does a
19 pilot know about rudder limiting and what its function
20 is?

21 A Prior to 587, I would have thought that the
22 pilots knew quite a bit, but after 587 it became
23 apparent that the industry as a whole, and the NTSB
24 safety recommendation addressed that issue in February,
25 but the industry as a whole, I think, pilots didn't

1 know much about rudder limiter system and in fact,
2 possibly had wrong perceptions. Most pilots think that
3 a limiter on some system will protect you in that
4 system, protect the pilot from exceeding whatever
5 parameter that limiter is limiting. And in this case,
6 in particular the rudder, I think pilots, and it's not
7 unique to the Airbus aircraft, it's all aircraft that
8 the pilots think that the rudder limiter will protect
9 the aircraft, structurally, and if it can't they --
10 they think, and we have limitations in our operating
11 manuals, that there would be a limitation or a warning,
12 or caution or a note that would indicate that --
13 indicate that the rudder limiter couldn't protect them,
14 structurally.

15 Q I asked Captain Rockliff yesterday the
16 question about the use of rudder on a normal flight
17 from the time the wheels are retracted until they are
18 extended. I'd like to ask you the same question. Do
19 you believe that the amount of rudder that you use
20 during the climb, cruise, descent, approach portion of
21 flying is limited or is it used extensively by pilots?

22 A I don't think pilots use the rudder very much
23 at all -- cross wind take off and landings, and then if
24 you had some type of malfunctions, i.e., engine failure
25 or a control malfunction that might induce some yaw or

1 side slip on the aircraft, then they would use it, but
2 for your question in normal flight, taxi out, taxi in,
3 they're probably going to use a little bit, rudder
4 checks, things like that, and then for cross wind take
5 offs and landings. I think that would be the majority.

6 Q Do you think most pilots fly with their feet
7 on the rudder pedals once they've gotten into the climb
8 regime or have engaged the autopilot?

9 A I think that pilots --- the pilot flying
10 would fly with his or her feet on the rudder pedal
11 while they're hand flying, but I think once they turn
12 the autopilot on that they would not fly with their
13 feet on the rudder pedal.

14 Q I'd like to ask you the same question I asked
15 Captain Rockliff yesterday, and I'd like your
16 definition of what coordinated rudder means to you?

17 A I thought Captain Rockliff's answer yesterday
18 was appropriate. I think it is without -- flying the
19 airplane without side slip or yaw on the aircraft, and
20 pilots are taught this from the very beginning, the
21 first hour of flight, regardless of what airplane they
22 fly is to fly the airplane coordinated, and it's
23 certainly very easy to detect when it's not
24 coordinated.

25 Q Moving to another area, there's been

1 discussion about the trapezoid or the side slip
2 indicator.

3 A Yes, sir.

4 Q How much of that device is used during normal
5 operations by a pilot?

6 A I think when you get side slip on the
7 aircraft that the first thing you're going to notice,
8 and what draws your attention to side slip or yaw on
9 the aircraft, is what you feel in your butt, in the
10 seat, and you'll make the big adjustments from that,
11 and then the fine tuning of yaw or side slip is done
12 with the side slip indicator, in this case, the
13 trapezoidal index, that trapezoid you're talking about.

14 So to use it for gross corrections, or large
15 corrections, I don't think it's used very much, until
16 you kind of get the airplane back in coordinated
17 flight, and then you'll fine tune it with that
18 trapezoid.

19 Q So you don't think during an upset recovery
20 demonstration or being involved in one in the
21 simulator, that that particular indication would be
22 used much by pilots?

23 A Not during the upset recovery itself, not
24 until you get back to a normal flight regime and you're
25 fine tuning the yaw and side slip, is when I think it

1 would be used.

2 Q Another definition we talked about yesterday
3 was the maximum maneuvering speed. Could you give me
4 your definition of what the maximum maneuvering speed
5 is?

6 A Vmax, is that what you're speaking of?

7 Q VA.

8 A Maneuvering speed. Maneuvering speed, pilots
9 are always taught from the beginning when they start
10 flying that below maneuvering speed that you have use
11 of full controls, primary flight controls -- that's
12 ailerons, elevators and rudder, and that below that
13 speed that using full controls that you would not
14 damage the aircraft, and if there's a possibility of
15 damaging the aircraft, that the manufacturer would put
16 a limiter or even put a limitation in the book, or
17 something to alert your attention to that.

18 Q Is there any limitations that were provided
19 to you by Airbus, either through their FCOM or through
20 other communications, that would have made you place a
21 limitation of sort in your operating manual?

22 A In relation to the rudder?

23 Q Yes, sir.

24 A No, sir, not prior to the 587 accident.

25 Q And since the accident, has there been

1 communication or warnings or cautions?

2 A Sir, since the accident, since the 587
3 accident, we've had communications with Airbus as well
4 as many other aircraft manufacturers -- Boeing,
5 primarily -- and the NTSB and a lot of agencies about
6 this whole concept of maneuvering speed and rudder
7 reversals, rudder doublets of which there was a lot of
8 new information coming to us from that. So Airbus did
9 send us a bulletin addressing some issues with the
10 rudder post after the 587 accident, yes.

11 Q What is your opinion of the knowledge, just
12 general knowledge, that American pilots might have had
13 concerning terms such as doublets, singlets, triplets,
14 Dutch roll?

15 A I think Dutch roll they heard of before
16 because we address that in the simulator -- very early
17 in the simulator phase, we do an exercise with that.
18 As far as the term doublet and singlets and triplets,
19 et cetera, I don't think it's isolated, in my opinion,
20 I've talked to lots of pilots, many, many pilots from
21 other airlines as well as ours, American Airlines
22 pilots, and most had never heard of the term before,
23 unless they were involved in the test business. That's
24 the only people that I found that actually knew what
25 the term meant. So I don't think they were aware of

1 the terms at all prior to the 587 accident.

2 Q In your experience, do you think that there's
3 ever a time that full aileron or full rudder would be
4 required on an A300 to control the airplane?

5 A I have never experienced that. When you fly
6 the A300, I mean the controls feel very powerful, and a
7 small amount will get you a lot. They feel powerful.
8 But if you found yourself in an upset and the aircraft
9 was rolling and you had exhausted all of your roll
10 controls, then I would expect to use some rudder if I
11 needed to avert that roll, and it could possibly end up
12 being up to full rudder, yes, sir.

13 Q Did American Airlines ever train their pilots
14 on the fact that the rudder pedals become restricted as
15 increased air speed occurs?

16 A Specifically to address that prior to 587,
17 no, sir.

18 Q Did you have knowledge that the rudder pedals
19 would be restricted?

20 A Not prior to 587, no, sir.

21 Q And why was that?

22 A You don't push the pedal to the stop on a
23 normal basis. The only time that I really experienced
24 getting the rudder pedal to the physical stop was
25 during simulator training with an engine failure, high

1 gross weight, high altitude -- high, hot and heavy, if
2 you will -- and then it would require maybe to the
3 physical stop of the rudder limiter. But outside of
4 that, I had never experienced touching the stop on the
5 rudder pedal before. I've shut down an engine on the
6 A300 before during a functional check of the aircraft,
7 and you don't -- at 250 knots and a descent, so the
8 power's back, and so it didn't require much rudder at
9 all with the power being back.

10 Q Did you happen to see stop on the rudder
11 pedal at 250 knots?

12 A No, sir, I did not.

13 Q Have you ever hit the stop on the rudder
14 pedal, either in a flight test airplane or in a real
15 airplane?

16 A No, sir.

17 Q In flight, I mean, obviously. When you're on
18 the ground taxiing out, doing a flight control check --

19 A Right.

20 Q -- certainly allows the rudder pedals to go
21 full travel in both directions to insure the system is
22 contiguous and is operating normally.

23 A Correct, on the ground we do the check, and
24 so you do take it to the stops. But never in flight.
25 I have never experienced the rudder pedal to the stops

1 in flight.

2 Q We talked yesterday somewhat about the
3 landing gear procedure that is incorporated in your
4 A300 manual, and is also in the FCOM. You had a
5 procedure that attempted to extend the landing gear
6 that was not locked down and the procedure called for
7 alternating side slips.

8 A Yes, sir.

9 Q What do you think that that meant, based upon
10 the original -- or the latest revision 25 of the FCOM,
11 which was in place at the time of the accident?

12 A As I read the FCOM and we incorporated that
13 procedure into our operating manual, alternating side
14 slips -- prior to 587 -- I would have thought that you
15 would have conducted alternating side slips to try and
16 get the gear down, and that would have been extreme
17 rudder movements from left to right, to try to get the
18 gear down and locked. That's how I would have read
19 that prior to 587.

20 Q And having read the revision that came out
21 post-accident that provided additional information as
22 to what alternating side slips mean, what's your
23 opinion of that revision?

24 A I thought they tried to explain something
25 that was already in there through some method that

1 didn't really explain the procedure, and so we chose
2 not to do that procedure. We have eliminated the
3 alternating side slip part of that procedure for the
4 landing gear unsafe procedure and we do not follow what
5 Airbus said there.

6 Q So they had, in their revision, they extended
7 -- I think there was about 12 lines of information
8 basically describing what alternating side slip means,
9 and it's my understanding that American now has
10 eliminated all that alternating side slip from their
11 procedure.

12 A That's correct. When we got the alternating
13 side slip explanation -- alternating side slip was
14 excessive from left to right and right to left -- as we
15 read it prior to 587. After 587 there was information
16 that came out about side slip and issues involved with
17 that as well as rudder reversals and rudder doublets,
18 et cetera, and we put a pink bulletin, which is an
19 immediate nature, in our operating manual that states -
20 - and I don't have it right in front of me -- but it
21 states that do not do the alternating side slips, that
22 if you have a landing gear unsafe procedure that you're
23 working down that check list, to conduct turns of 45
24 degrees and that'll give you some G's available to
25 maybe try and get the gear unlocked, or excuse me, down

1 and locked. Is that clear? I'm not for sure I -- we
2 disagreed with their explanation -- Airbus' explanation
3 of alternating side slip and we're not going to do
4 that, based on our knowledge today that we didn't have
5 before. And so we do 45 degree turns one way, 45
6 degree turns another way to try and get the gear down
7 and locked, and that is what our procedure is now,
8 today.

9 Q Do you think that prior to the accident that
10 most airline pilots, and you certainly should be able
11 to speak for the American A300 cadre, that most airline
12 pilots believe that if you were below the maneuvering
13 speed that you could exercise the rudder to its full
14 authority in alternating side slips, and if there was
15 to be any potential problem, that a rudder limiting
16 device would protect you and preclude any kind of a
17 disastrous effect, such as we had in this accident?

18 A I do believe that very statement. I think
19 that pilots, prior to the 587 accident, thought that if
20 you were below maneuvering speed that the rudder
21 limiter would protect the aircraft, structurally, and
22 that you could move the controls as necessary without
23 risk of damaging the aircraft. Yes, sir, I do.

24 Q And was maneuvering speed ever provided as a
25 limitation or a speed that was incorporated in your

1 manual in any shape, form, or fashion, or provided to
2 you by Airbus?

3 A Yes, sir. In the flight manual -- the Airbus
4 flight manual -- it does have maneuvering speed, and we
5 saw that chart yesterday, and some of the verbiage that
6 is in it. We incorporated that into our operating
7 manual -- American Airlines' operating manual as
8 turbulence penetration speed, and that was 270 knots,
9 and that was the minimum speed on that maneuvering
10 speed chart. And so -- I don't think airline pilots --
11 my personal opinion is I don't think airline pilots
12 specifically fly around thinking about maneuvering
13 speed. No, that's not what I think at all. But, there
14 is no limitation or restriction in the book that would
15 bring your attention to the fact that they didn't have
16 full use of the controls at those speeds. Certainly at
17 high speeds, we know there's some restrictions, but not
18 at the lower speeds, no, sir.

19 Q My last question, do you believe that the
20 AAMP program meets the needs of the American Airlines
21 pilots in training them sufficiently for recovery from
22 upsets and wake turbulence encounters in its present
23 state?

24 A I think that in the mid-90's there was a lot
25 of concern about this, and there has been examples of

1 this type training saving aircraft and passengers. So
2 I think it's valuable training, and I think we need to
3 continue training in upset recoveries, yes, sir.

4 CAPTAIN IVEY: Thank you, Captain Young, Mr.
5 Ghoshal. Madam Chairman, I'd like to turn the
6 questioning over to Dr. Malcolm Brenner.

7 CHAIRMAN CARMODY: Please proceed.

8 QUESTIONING OF CAPTAIN YOUNG

9 BY DR. BRENNER:

10 Q Following up on Captain Ivey's questions.
11 Are there some statistics or trends that we can
12 monitor? How do we judge the effectiveness of the
13 program?

14 A I don't have those statistics available to me
15 right now, but I'm sure that if you look at the
16 accidents -- certainly in the mid-90's there, the
17 Pittsburgh accident with the 737 was high profile and
18 it had been the second one of that particular type that
19 generated some of these bulletins and the industry
20 concern over that. So if we went back and looked from
21 1995 or 1996 to date, I think we could validate some of
22 those concerns.

23 Now, there have been specific examples of
24 pilots attributing this type training to saving their
25 aircraft and passengers. Statistically, I think we'd

1 have to go back and look.

2 Q When you receive these types of reports from
3 pilots about the program saving them, how much follow
4 up is there or informal contact to guarantee the way
5 the way they use the techniques and to guarantee how it
6 affected the situation? Is there a follow up on that?

7 A And I'm talking as an industry as a whole,
8 not necessarily American Airlines, if another carrier -
9 - if they contact us and talk to us about a save or
10 something with an aircraft as a result of this
11 training, certainly we'd ask some of the details. But
12 to go and interview the pilot or something like that,
13 probably not.

14 Q Do we learn enough to improve the program?

15 A We try and validate what they said that was
16 useful for them in the recovery of the aircraft and the
17 upset. But we do try to look and get some validation
18 of if we're teaching the right thing, and do we need to
19 address any other issues that may be lessons learned
20 from whatever they experienced at the time.

21 Q Yesterday we discussed the in flight upset
22 involving flight 903, American Airlines 903 from 1997.

23 A Yes.

24 Q And in that case, I believe, that the pilots
25 involved had recently completed an AAMP a few months

1 before. Did they correctly apply the guidelines that
2 they received in the program?

3 A I wasn't on the accident investigation of
4 903. I've read through some of the materials, quite
5 extensive as you would know. I think the aircraft was
6 in an upset condition, regardless of how it got there,
7 it was in an upset condition, and they recovered the
8 aircraft. And from what I understand, reading the
9 reports, was that it was in a right bank and was 56
10 degrees and continuing to roll right with full left
11 roll controls, and the aircraft was continuing to roll
12 right, so they applied some rudder to help avert that
13 roll and get upside down, so in that case, yes, it
14 sounded like -- AAMP always taught to use your roll
15 controls first, and then apply rudder if you need some
16 additional -- so in that context, yes, sir, I think so.

17 Q And was it appropriate for them to apply an
18 escape maneuver?

19 A As I -- as I understand, after reading
20 through some of the context, that they thought that
21 they were in some type of a microburst or wind shear
22 condition at the time, so if they thought that, yes,
23 sir, it would have been appropriate.

24 Q Did American Airlines make any changes in its
25 AAMP training program as a result of that event? Were

1 there any lessons learned?

2 A The lessons learned, and specifically to the
3 A300, we -- the SGUs or displays that display your
4 attitude and air speed and some other things,
5 navigational things -- they blanked, or they went into
6 computer mode that it was no longer available to the
7 crew there for a few seconds, and so we did incorporate
8 that into our training and we talk about it, because it
9 would make recovery more difficult without having some
10 instrumentation available to you. We did incorporate
11 that. But as far as some of the other updates, no,
12 that was about it.

13 Q And I think yesterday we talked about Captain
14 Tribout's letter which was shortly after the 903 event,
15 that he wrote to Airbus. He was very concerned about
16 the AAMP training on rudder use was inaccurate and
17 potentially hazardous and asked for guidance. Can you
18 put that in context? Can you tell us about that letter
19 and what may have come out of that?

20 A I can, and I've spoken to Captain Tribout
21 recently. At the time -- this was a May 1997 letter,
22 and he was looking at a book that we had produced in
23 1996, and there was a statement -- and I think Member
24 Hammerschmidt brought it forward yesterday -- about the
25 rudder being a primary roll control. And that

1 concerned him. He had not taken the full class. He
2 had not taken the class at all, he had just looked at
3 the workbook. And as you look at the workbook -- and
4 once again, as I spoke earlier, it was not a stand
5 alone document, and by the time the 1997 workbook came
6 out, we had update that verbiage to say, instead of
7 primary roll control, the most effective roll control.
8 And we're speaking specifically to high angles of
9 attack.

10 His letter to Airbus might -- as I read
11 through the letter, and I had not seen it prior to I
12 suppose a week or two ago when it was entered into the
13 Exhibits -- but as I read through the letter, what I
14 saw was a dialogue between our technical group and
15 Airbus, the technical people on the airplane there.
16 And I would expect that. As a standards manager, we
17 develop training programs in the training department,
18 but we rely on technical expertise from the technical
19 department, and that's where he was. He's not
20 responsible for developing training programs, but he is
21 responsible for advising us on technical issues. So as
22 I read through it, I saw dialogue between the aircraft
23 manufacturer and the user.

24 Q Do I understand that there were changes then
25 in the guidance on the use of rudder during that time

1 period? Is that what you said, or --

2 A No, what we did was we clarified verbiage in
3 the workbook which was not -- it was supplemental
4 material. It was not a stand alone document. The full
5 eight hour course -- one of our concerns, even to put
6 the workbook out, and quite frankly, it's still a
7 concern today, is that someone would get the workbook
8 and only read through the bullet statements. There was
9 a full day of ground school that we would teach, and
10 sometimes those single bullet statements we'd talk
11 about for ten or 15 minutes, perhaps, and instruct it -
12 - and one of our concerns was that initially, even with
13 the workbook, and it still is today that someone could
14 get that workbook, didn't take the class, and didn't
15 understand fully the concept from that single bullet
16 statement and -- and that's what we saw there, and
17 that's -- there have been several changes to the
18 workbook over the years, not so much in course content,
19 but in clarifying what we were already teaching and
20 putting it in bullet statement format in the workbook.

21 Does that answer your question?

22 Q I think so, I tried.

23 A I'm sorry, it's a little long.

24 Q In the middle of 1997, is when the accident
25 crew took their ground training in AAMP, had there been

1 changes in the guidance or the material around use of
2 rudders, specifically, from then to now? Is the
3 guidance still accurate or have there been
4 modifications in it? Can you help me on that?

5 A The guidance is still the same. I think you
6 saw from the video clips, and that was from 1997, and
7 in fact, First Officer Molin took the class in March of
8 1997, and he very well could have been in one of those
9 film clips, or in the class when one of those film
10 clips were being filmed, and Captain States took the
11 AAMP class in May of 1997. So what you saw in the film
12 clip there is what they saw, and that's what we teach
13 today.

14 Q We have a report in our docket I'd like you
15 to, again, help us put that in context. This is the
16 interview with Captain LaVelle, it's Exhibit 2-B. He
17 reports in 1997, he experienced with the acting First
18 Officer, Mr. Molin, and although he says that Mr. Molin
19 had excellent pilot skills in general, he had a strange
20 tendency to be very aggressive on the rudder pedals,
21 and specifically he reports that the First Officer
22 responded inappropriately to a wake turbulence
23 encounter by commanding aggressive back and forth
24 rudder inputs, and further, that when he admonished the
25 First Officer, the First Officer insisted that the AAMP

1 gave him directions to use rudder pedals in this
2 fashion. Is it possible that this one pilot received
3 negative training?

4 A The short answer to that is no. I think you
5 clearly saw from the video clips that that's not what
6 we were teaching. Captain LaVelle came to me and
7 talked to me about this during the course of this
8 investigation, and I then forwarded it to the NTSB, to
9 Captain Ivey. We're committed to making sure this
10 never happens again, so we are going to forward all the
11 information as it comes in.

12 I need to put the whole Captain LaVelle thing
13 into context. We, as a group, as the NTSB group, have
14 interviewed pilots, several pilots that had flown with
15 First Officer Molin subsequent to Captain LaVelle.
16 Captain LaVelle was speaking of an incident in 1997 on
17 the 727. And we spoke to several pilots that had flown
18 with First Officer Molin as recent as a month prior to
19 the accident, and some of those pilots -- if you add
20 them all up together, there were hundreds of legs.
21 Captain LaVelle had flown a total of six. So -- but
22 even if that did happen, I mean as you saw the video
23 clips which was actual class instruction, clearly
24 that's not what we said on how to use the rudder. And
25 even Captain LaVelle states in his testimony that

1 that's not what AAMP taught. He debriefed First
2 Officer Molin on the spot and by testimony by pilots
3 since that have flown hundreds of legs, there's no
4 evidence that he did that again at all. Does that
5 answer your question. I'm sorry I'm a little long
6 winded, there, but --

7 Q No, that's very well. I would like to
8 acknowledge Captain, you did come forward with Captain
9 LaVelle. We appreciate that support in the
10 investigation. As an industry, we're all trying to
11 figure out what happened and we appreciate the
12 airline's cooperation in this, and as in many other
13 events, especially in coming forward with that.

14 A Well, thank you. We're committed to finding
15 out what happened. Facts are the facts, and make sure
16 it never happens again, to any carrier, much less
17 American Airlines.

18 Q I wanted to ask about the simulator exercise.
19 In the case of the roll exercise, how do you introduce
20 that to the pilot?

21 A As I've stated, the instructor will select
22 and this -- we have recently disabled that button, and
23 we put them into an upset into a different manner now -
24 - but they select the roll maneuver on the simulator
25 panel -- instructor panel -- and the simulator will do

1 the exercise that Mr. Ghoshal talked about.

2 Q And I understood that there was an
3 introduction that you're taking off behind a heavy
4 airplane that was often used by instructors. Is that
5 accurate?

6 A That is often used, that you're taking off
7 behind a heavy jet and oftentimes the instructor will
8 even say a 747. Normally they have the weather in the
9 simulator clear or certainly good weather to where
10 there's a horizon and some other things, some visual
11 clues available, although primarily the student, or the
12 pilot, will use the instruments inside the cockpit.
13 But many times, yes, the instructor sets it up by
14 saying you're behind a heavy jet, a 747, cleared for
15 takeoff, and then after they get airborne and they
16 start cleaning up the airplane, then we'll initiate the
17 roll maneuver.

18 Q About what air speed are they going when you
19 initiate it?

20 A It would vary with instructors, and it
21 depends on the altitude and things and what they're
22 trying to do. The roll maneuver, although the
23 instructors mention wake behind a heavy jet or
24 something like that, as we stated earlier in the
25 presentation, we had very specific reasons of why we

1 initiated this roll maneuver the way we did, and part
2 of it was our investigation of accidents that once
3 pilots had gotten beyond 90 degrees, sometimes they
4 continued to pull. It was a very unnatural act for
5 transport category pilots, in particular, to push and
6 help them in their recovery, so we were driving to a
7 specific point. We wanted our pilots to get beyond 90
8 degrees so they were forced to systematically push on
9 the yoke to help them recover from this upset. So
10 although -- it was a convenient way to introduce this
11 maneuver, saying you were behind a heavy jet or
12 something, but I don't think any pilot would ever
13 think, certainly on a large aircraft like this, that,
14 unless you have short wings or whatever, that you'd
15 find yourself in an upset from wake turbulence.

16 Q Would the pilots experience the upset at 250
17 knots? Did that ever happen?

18 A Once you get to 250 knots, the preprogrammed
19 button was removed, and it was no longer selectable by
20 the instructor. So up to 250 knots you could have --
21 they could have selected it.

22 Q And in general, how much simulator -- would
23 pilots have simulator training using the rudder in the
24 area of 250 knots? I know you talked about ground
25 school training, but is there any simulator training

1 where they experience it?

2 A Outside of maybe getting an engine failure at
3 that speed or something like that. We conduct engine
4 failures at critical phases of flight and the majority
5 of time, in most pilots' experience over the years,
6 have been down in -- at lower speeds than 250 knots,
7 but an instructor could introduce an engine failure at
8 that or control malfunctions or something like that at
9 that speed, but -- that would be probably the extent of
10 the rudder experience at that 250 knot range.

11 Q In the training, the pilots are trained to
12 use the rudder in the amount the crew feels is
13 necessary to obtain the desired roll, and I think the
14 training is, to use a smooth application of small
15 amounts of rudder coordinated with aileron. Is that
16 appropriate? Is that accurate?

17 A If you're not getting the desired roll
18 response at high angles of attack -- now, we're
19 speaking about very specific conditions here -- at high
20 angles of attack, you're not getting the desired roll
21 response from the roll controls, then a small amount of
22 rudder to arrest that roll that you're trying to do
23 would be appropriate, yes.

24 Q I guess the concern is that if the pilot has
25 very limited experience or no experience with rudder

1 properties at these high air speeds, how can they judge
2 what would be an appropriate amount to apply?

3 A At the higher air speeds, and this is
4 probably beyond this discussion here, but the higher
5 air speeds, you are not going to be at a high angle of
6 attack, because you just don't have the G available to
7 put yourself at a high angle of attack, and we always
8 taught at low angles of attack, utilize your roll
9 controls. I would expect that at low angles of attack,
10 that the roll control should get you what you need in
11 response to an uncommanded roll.

12 Q In terms of the simulator exercise, a
13 possible criticism is that the A300 is such a large
14 transport that a 90 degree roll in response to a wake
15 turbulence may be unrealistic, and perhaps that the
16 exercise should be graded according to the size of the
17 fleet. Is this a concern, that there is possible
18 negative training, it may give unrealistic expectations
19 of the effect of a wake.

20 A I know that's been brought up during this
21 accident investigation, and like I said, we were
22 driving to a very specific point. We wanted to get,
23 regardless of the airplane, we wanted to get them to 90
24 degrees. Now, some of the instructors over time have
25 utilized the wake turbulence because, as I said, the

1 weather was typically pretty good in the simulator.
2 They would set the weather where it was good, and we
3 didn't want to give a multiple failure, i.e., some type
4 of a control malfunction in order to get them to 90
5 degrees because then they have something else to deal
6 with. We just wanted to teach them that once they got
7 beyond 90 degrees, that they needed to push. That if
8 they continued to pull, they could find themselves in a
9 very nose low attitude, possibly reducing the chances
10 of recovery. And we base this on accident
11 investigations, specifically the US Air 427 in the mid-
12 90's there, was -- addressed that. So, if it's
13 negative training -- pilots all over the world
14 experience wake turbulence on a regular basis, so I
15 don't think for a moment that an airline pilot,
16 certainly, when they encounter wake, certainly on a
17 large aircraft, think that they're going to get upside
18 down. No, I do not think that at all.

19 Q There was a -- I'd like you to comment on
20 another interview in our Exhibit, also Exhibit 2-B,
21 this is the interview with Mr. McHale, and he also
22 reports a 1997 event with First Officer Molin, who was
23 involved in the accident, in which he reports that
24 First Officer reacted aggressively to wake turbulence
25 encounter by executing an immediate escape maneuver

1 when the airplane experienced the wake from a smaller
2 airplane. I think they were following a 737 or a 727.

3 Could this be an example of negative training for this
4 particular pilot?

5 A Could what be an example? I'm sorry.

6 Q In terms of expectations that this is perhaps
7 an example of what we're talking about, that to him,
8 perhaps, experiencing wake turbulence, he's learned in
9 a simulator exercise, perhaps --

10 A Right, I understand.

11 Q -- as an example, to experience that he may,
12 without effective controls, end up in a 90 degree angle
13 unless he's very aggressive. Is that possible that he
14 overreacted?

15 A Without being there in that situation, in
16 that airplane, I think it's difficult for me to judge
17 on that, but what I do know is that -- we don't
18 criticize pilots for making a decision to go around.
19 If you're not in a position to make a safe landing,
20 then to go around or to execute a missed approach would
21 be the proper procedure. And if -- if there was some
22 question about the flying capabilities of that
23 aircraft, and to land safely in this case he was on
24 final, to go around or execute a missed approach, I
25 think would be appropriate. But without specifically

1 being in that airplane and knowing what went on
2 exactly, I think that's difficult for me to make a -- a
3 decision right now on the spot.

4 Q And I think there was another possible
5 criticism of the simulator training program again, that
6 it may have an unintended side effect that by rendering
7 the controls ineffective for several seconds, it might
8 encourage pilots to respond very aggressively on the
9 controls, especially if the pilot finds that the main
10 roll control is ineffective during that period, to come
11 back very aggressively on the rudder. Would that be a
12 fair criticism?

13 A I don't think so. I mean, I don't think any
14 pilot that walks into a simulator thinks that they're
15 going to fly from point A to point B and have a normal
16 flight. We just don't have that flight time available
17 in the simulator. So to say that they're conditioned,
18 if they experience wake turbulence to immediately go to
19 full control, I do not think that that's a fair
20 criticism, and I don't believe that. If the aircraft
21 was starting to do something strange, i.e., roll over
22 or do some type of extreme maneuvering, then maybe they
23 would get to that. I don't think the simulator
24 preconditions people to responses like that of which
25 you speak.

1 MR. CLARK: Let me ask a couple quick
2 questions while you're still in that area.

3 THE WITNESS: Yes, sir.

4 MR. CLARK: As I understand it, how often do
5 these pilots get this roll mode type of failure in the
6 upset training?

7 THE WITNESS: In the simulator, they'll get -
8 - for recurrent training, we have four days of training
9 -- two days of ground school and two days of simulator,
10 of which the simulator periods are four hours each with
11 --

12 MR. CLARK: Well, how many times do they get
13 this particular mode? Once a year? Twice a year?
14 Once a career?

15 THE WITNESS: They'll get it once every nine
16 months now.

17 MR. CLARK: Okay, then my question is, I
18 think Mr. Ghoshal talked about it -- it takes about ten
19 or 11 seconds for this thing to develop -- if you
20 introduce the roll mode and you lock out the controls
21 for what? ten or 11 seconds, something like that?

22 THE WITNESS: No, it's to 50 degrees.

23 MR. CLARK: Okay, to 50 degrees. It takes
24 about that time to develop it. The question is, once I
25 start rolling, what is a pilot's first appropriate

1 response?

2 THE WITNESS: To use the roll controls.

3 MR. CLARK: Up to the maximum.

4 THE WITNESS: Up to the maximum, yes, sir.

5 MR. CLARK: What's the second response?

6 THE WITNESS: If they're not getting the
7 proper roll response that they want from the aircraft,
8 then they would probably apply, and what we see, is
9 they apply some rudder.

10 MR. CLARK: As much as necessary, I think is
11 some of the language?

12 THE WITNESS: That's what it says, as much as
13 necessary.

14 MR. CLARK: And then some of these controls
15 move on beyond 50 degrees before the roll is stopped
16 and the recovery actually starts.

17 THE WITNESS: Yes, and once again, I mean I
18 refer back to we were driving to a specific point of 90
19 degrees, to address this whole elevator --

20 MR. CLARK: But over this amount of time, and
21 I still think -- it's not a time-based thing, but it
22 takes ten, 11 seconds for all of this to develop, first
23 step is to get in the wheel, the second step is to get
24 in the rudder. Doesn't that set you up to use a lot of
25 wheel, a lot of rudder each and every time you go

1 through this maneuver?

2 THE WITNESS: Well, in this particular
3 maneuver, I think that it does teach that we exhaust
4 the roll controls and then we use the rudder. This is
5 very small -- out of eight hours of simulator once
6 every nine months, the maximum time that they would
7 spend doing all of this stuff, which would include not
8 only the roll maneuver and upset, but it would include
9 controlled flight into terrain, enhanced GPW training,
10 TCAS training -- all of that would be a total of about
11 15 minutes in the simulator. So do I think doing this
12 maneuver once every nine months, pre conditions pilots
13 to expect to use full roll controls every time they get
14 into some turbulence or some wake turbulence,
15 absolutely not.

16 MR. CLARK: Okay, but it would appear that
17 they need to use full -- or almost full control each
18 and every time this mode is introduced.

19 THE WITNESS: No, it's -- it depends on the
20 pilot reaction of what happens. As I said, we're
21 driving him to a 90 degree bank -- and different pilots
22 will do different things. Some pilots don't use the
23 rudder, and other pilots do to arrest the roll control.
24 So -- do we drive every pilot to use the rudder
25 because the roll controls are ineffective? No, we

1 don't do that, but through the AAMP ground school
2 instruction, they do understand the concepts that the
3 rudder can be used as a secondary roll control -- or
4 the secondary effect of the rudder is roll if the roll
5 controls are not working.

6 MR. CLARK: And then I'll just jump in one
7 more and I'll give it back to Malcolm. In the 587
8 scenario, you're familiar with the data and following
9 through on the lead in. Is there anything in there
10 that would -- is there any training that you provide
11 that would encourage a pilot to simultaneously use the
12 -- a lot of wheel and a lot of pedal, based on what is
13 happening in this 587 scenario?

14 THE WITNESS: From what I've seen in the
15 data, I haven't seen anything that would indicate that
16 the aircraft was ever in any type of upset. Specific
17 to the rudder, if a pilot doesn't need to roll the
18 airplane, at a high angle of attack and has exhausted
19 the roll controls, in this case, the only time I would
20 expect a pilot to utilize the rudder outside of that is
21 if you end up with some yaw or side slip on the
22 aircraft and you're trying to get it back to
23 coordinated flying. Does that answer your question?

24 MR. CLARK: Yes, that's fine. Sorry, Malcolm

25 DR. BRENNER: Okay.

1 BY DR. BRENNER:

2 Q In the simulator exercise, I understand you
3 do not record the pilot's inputs on the rudder. How do
4 you evaluate their use of the rudder?

5 A It's really an individual instructor and --
6 to just watch the pilots of how they execute this upset
7 procedure, so that's really how we evaluate it.

8 Q And in wake turbulence maneuvers, what's the
9 guidance, or when would it be appropriate to respond
10 with a full wheel?

11 A A full aileron or roll controls?

12 Q Yes, that's right.

13 A If you were getting some kind of a roll, and
14 you put in a roll control, and the roll on the airplane
15 continued -- an unintended roll -- continued, then I
16 would expect the pilot to use all the way up to the
17 full roll controls, to arrest that unintended roll.

18 Q And when would it be appropriate to use full
19 rudder?

20 A Well, first of all, prior to 587, I don't
21 think any pilot in the world thought that full rudder
22 could be gained from an inch and a quarter of movement
23 at 250 knots with ten pounds of pressure. But, if
24 there was side slip on the aircraft, I think the pilot
25 would put in the rudder to the amount to arrest the

1 side slip and pull the airplane back into coordinated
2 flight.

3 Q And would the guidance be to apply the rudder
4 -- what would the timing be in terms of -- would the
5 rudder come simultaneous with aileron, or after, or
6 before?

7 A If you're in a low angle of attack, and you
8 get roll, I'd expect him to roll with roll controls,
9 and there would be no reason to use the rudder. But if
10 you're at a low angle of attack, and you get side slip,
11 then I would expect him to use the rudder. Now,
12 whether that's at the same time or close together, I
13 can't say. But at high angle of attack, if they
14 exhausted their roll control, then I would expect them
15 to come with the rudder, so I would expect the roll
16 controls to lead in that case.

17 Q In the CVR transcript, the First Officer
18 called for max power during the event. Is this a
19 normal call out or a nonstandard call out?

20 A For an encounter with wake turbulence?

21 Q Yes. What is he doing? What is he calling?

22 A Most of my experience with wake turbulence,
23 and as I talk to pilots, it's very short, it's just --
24 you hit the wake turbulence and you're through it. And
25 so you don't really -- are in there very long to

1 react. In this case, as I've read through, just
2 yesterday when I looked through the CVR transcript, I
3 think he was asking for power to get out of something
4 that they were in, whatever that was.

5 Q Under the company guidance, is max power an
6 escape maneuver? Is that correct?

7 A It could be part of the wind shear
8 microburst, yes, procedure, which is the only time that
9 you would use the word escape.

10 Q I see. Or is there any -- when is the
11 command max power used? Can you help us out on that?

12 A During the wind shear microburst procedure,
13 you would ask for max power during that procedure. Not
14 necessarily an upset procedure, and we talked about the
15 thrust vector effect during my presentation. You would
16 not necessarily, categorically, just ask for max power,
17 and certainly if you were in a nose low condition, you
18 wouldn't ask for max power.

19 Q And according to the CVR transcript, the
20 Captain replied, "You all right?" He did not, and
21 according to the FDR data, did not change the power
22 setting. Why did the Captain not provide full power as
23 the First Officer requested?

24 A If you ask for max power, my personal opinion
25 is that that could be two different definitions. One,

1 is the normal max power that you use during climb out.

2 And another max power would be to the firewall of the
3 aircraft, where you're no longer concerned about
4 overtemping the engines and taking them outside of
5 their parameters, you're concerned more about getting
6 power to recover the aircraft. So those two -- I can't
7 sit here and say what Captain States was thinking at
8 the time, nor First Officer Molin, what they were
9 actually -- what he wanted and what he was asking for.

10 But those are the two definitions that I would think
11 of as max power.

12 Q Thank you, that's very helpful. And you
13 talked about the Safety Board recommendation that came
14 out in February regarding pilot training and the
15 operation and the human factors of rudder systems, is
16 American Airlines instituting actions as a result of
17 the recommendations?

18 A Yes, sir, we are. Right after the
19 recommendation came out, and of course we've had
20 dialogue with the NTSB as well as the party members
21 involved in this accident, we issued a technical
22 bulletin to our crews. We've issued revisions and what
23 we call our pink bulletins to our crews. We sent out
24 two separate packages of information to our crews to
25 address these issues of which we included the safety

1 recommendation as well as the Airbus response letter to
2 the safety recommendation, and the Boeing response
3 letter to the safety recommendation. We talk about it
4 now during ground school. We talk about it, we
5 illustrate during the simulator program, we illustrate
6 the restrictive rudder pedal movement and how sensitive
7 that is, and the force of the rudder pedal. We have
8 done several things. We've issued messages through our
9 electronic thing. We've posted information on our
10 pilots web site. I personally have, for the A300 in
11 particular, I have made base visits to field questions
12 from the pilots that they had, and it didn't always
13 center on just some of the issues in the safety
14 bulletin, but to field questions and get the
15 information out there on the street. Because I think
16 there was some issues in the safety bulletin that were
17 clearly misunderstood or not well understood by pilots
18 all over the world.

19 DR. BRENNER: Thank you.

20 CHAIRMAN CARMODY: I understand that Mr.
21 O'Callaghan has some questions after you, Dr. Brenner,
22 is that correct?

23 DR. BRENNER: Yes, Madam Chairman.

24 CHAIRMAN CARMODY: Was that your last
25 question, Dr. Brenner?

1 DR. BRENNER: That's correct.

2 CHAIRMAN CARMODY: Okay, I just wanted to
3 clarify, after Mr. O'Callaghan, will there be more from
4 the tech panel, or -- possibly there will. I'm
5 debating whether to take -- why don't we go ahead. I'd
6 like to finish with the tech panel before we take a
7 break, so maybe we can aim for 10:30 or so. Thank you.

8 MR. O'CALLAGHAN: Madam Chairman, I'll try to
9 be quick.

10 QUESTIONING OF MR. GHOSHAL

11 BY MR. O'CALLAGHAN:

12 Q Good morning, gentlemen, thank you for your
13 presentations. My questions have to do with the
14 simulation, and also a little bit about the training.
15 Dealing with the simulation first. Mr. Ghoshal is the
16 upsets that you describe in your presentation, do they
17 apply to all aircraft operated by American or to just a
18 few?

19 A Yes, all American and American Eagle also.

20 Q Then, I'd just like to clarify something,
21 Captain Rockliff in his testimony yesterday said that
22 when he experienced the roll upset in the MD-11
23 simulator with the McDonnell Douglas pilot, it was his
24 impression that the roll control was inhibited as you
25 described, but he seemed to indicate that he thought,

1 or both pilots thought that the rudder was not. Were
2 they looking at a different version of the scenario, or
3 do you have any opinions on that?

4 A From day one that we developed it, this is
5 the way it was. Roll and yaw control were both phased
6 out and phased in at the same time.

7 Q Okay, thank you. Now, in your presentation
8 you mentioned that during the development of the roll
9 upset profile that the angles of attack and side slip
10 were monitored.

11 A Yes, sir.

12 Q And these were found to be within the valid
13 range of the database report?

14 A Yes, simulator alpha/beta plot that I showed
15 you.

16 Q Okay, thank you. And now, is alpha and beta
17 monitored for each student going through the program
18 for each run?

19 A No, sir, we don't.

20 Q But wouldn't the alpha and beta achieved
21 during the recovery depend on what each individual
22 student happened to be doing?

23 A Absolutely. When we developed it, we flew it
24 with quite a few pilots and looked at it, and it looked
25 pretty reasonable.

1 Q But for an individual student, it's not
2 monitored.

3 A No.

4 Q And you mentioned that the simulator is
5 capable of recording data.

6 A Yes, sir.

7 Q But is it in fact recorded and then used to
8 debrief pilots during the training?

9 A Not this alpha/beta pitch angle, bank angle,
10 no, we don't do that for AAMP.

11 Q And I think Captain Ivey asked this, but also
12 load factors and things like that are not recorded and
13 are not reviewed either, is that right?

14 A That's my understanding.

15 Q Thank you, that's --

16 MR. CLARK: Let me ask a follow on right
17 there, John. How do you know that it would have been a
18 successful recovery if you don't track those particular
19 elements? What is your basis to determine that the
20 exercise was successful?

21 CAPTAIN YOUNG: The basis for determining
22 whether the exercise was successful or not was
23 recognition to start with, and the second, proper
24 execution of the procedure. And we understand -- and
25 this is a limitation where, I mean, certainly if you

1 get the sim upside down, you don't go to negative G,
2 you don't hang in the straps, you don't have books
3 flying all over as you would in the airplane, and this
4 is just part of the limitation we live with the
5 simulator. But in this particular case, we're trying
6 to teach a specific procedure to an upset condition,
7 and so if they apply the proper procedure, then that
8 would be a successful.

9 BY MR. O'CALLAGHAN:

10 Q Mr. Ghoshal, going back to your presentation
11 again, you mentioned that plot that shows the range of
12 alpha and beta, and I think I heard you say that the
13 data that feeds that comes from flight test, wind
14 tunnel and perhaps extrapolation by empirical methods,
15 and my question was -- what I heard was as long as
16 there's a number in the database for a given angle of
17 attack and side slip that means that one can expect the
18 simulator to be representative of the real airplane.
19 Did I hear you correctly? Is that what you intended to
20 say?

21 A Yes, sir, and in reality, the data comes from
22 the aircraft manufacturer. We, as the simulator user,
23 or when I built simulators, we do not know which part of the
24 angle of attack is flight test, which is wind tunnel, which
25 is extrapolation. There is no way to know it. All we

1 know is it is given by the aircraft manufacturer and
2 their stability and control people have looked at it
3 and deemed it accurate enough for use in simulators.

4 Q So, can I take that to mean, then, that if
5 there is, indeed, then a number for an angle of attack
6 or a side slip, then as far as American Airlines is
7 concerned, that number has been blessed by the
8 manufacturer and therefore is representative of the
9 real airplane.

10 A Yes, sir, and also I quoted industry training
11 aid, it says the same thing also. Just a -- okay, the
12 industry training aid actually quotes the similar
13 thing, that it could be analytical data, extrapolated
14 data, anything you can use.

15 Q I think I saw in that chart, -- those
16 databases went out to some 30 degrees of side slip, and
17 possibly over 20 degrees of angle attack. Would you
18 expect, knowing your knowledge of simulators, that the
19 simulator would actually duplicate a real airplane in
20 that kind of condition?

21 A Some of the high side slip angles, yes, if it
22 is wind tunnel -- you know, wind tunnel is one of the
23 best to get high side slip angle data. But it is very
24 important to remember that most of the flight is done
25 inside the box, even when the aircraft is in an upset

1 maneuver, within that flight test box. The data that
2 we recorded in the simulator will always be in the
3 middle box -- most of the time, even in upset
4 maneuvers.

5 Q I understand the latter, but at the extremes,
6 though, you're giving separated flow conditions and
7 these sorts of things, do your simulators account for
8 that properly?

9 A The data come from aircraft manufacturers.

10 Q Okay, thank you. One second here.

11 QUESTIONING OF CAPTAIN YOUNG

12 BY MR. O'CALLAGHAN:

13 Q Moving on then to the pilot training, then, I
14 guess, Captain Young, yesterday Mr. Chatrenet described
15 for us how the rudder produces roll by first yawing the
16 airplane and inducing a side slip, and then how it's
17 actually the dihedral effect and the side slip angle
18 that produces the roll. Can you explain what the
19 significance of that mechanism is from a pilot's point
20 of view?

21 A I'm not for sure I completely understand your
22 question.

23 Q Well, the -- yesterday, Mr. Chatrenet
24 described how it is aerodynamically that the rudder
25 causes the airplane to roll --

1 A Right.

2 Q First thing it does is produce a yaw.

3 A Correct.

4 Q Which will create a side slip angle, and then
5 the dihedral effect of the airplane through the side
6 slip angle, produces the rolling moment that banks the
7 airplane. And he mentioned, you know, that there's a
8 delay -- first there's a movement in yaw, and then
9 there's a roll, so there's kind of a delay --

10 A Right.

11 Q And I was wondering, does that have any
12 bearing or any significance from a pilot's point of
13 view?

14 A From a pilot's point of view, I'm not an
15 aerodynamicist, but you know I understand some basics
16 about why an airplane rolls with rudder at high angles
17 of attack, or even for that matter, if you put in
18 enough rudder at low angles of attack and you wait long
19 enough, it could induce a roll. But when you first put
20 in the rudder initially, you're going to get some
21 adverse yaw, probably imperceptible to the pilot,
22 and then as the oversweep on swept wing airplanes, as
23 the oversweep takes effect, basically you have one wing
24 that's more effective than the other, and it induces a
25 roll as a result of that side slip, that causes one

1 wing to get out into the airstream more effectively,
2 should I say. And so -- but from a pilot's point of
3 view, if I needed some roll and I've exhausted my roll
4 controls, I'm going to put in a little rudder,
5 possibly, and it depends on the situation, but possibly
6 put in a little rudder to help that roll control if I
7 need that. So I don't sit there and think about am I
8 in a side slip, am I not in order to induce this roll
9 at that point in time. I'm trying to arrest an
10 uncommanded roll.

11 Q Now, in the presentation, the classroom
12 presentation of the AAMP that we saw saw some clips of,
13 is the mechanism that I described and that you
14 reworded, is that gone through in the presentation --
15 this mechanism, the physics of how the different roll
16 is applied?

17 A In detail. There's a -- the tape in the
18 mechanism -- the full class of the AAMP program, the
19 ground school presentation, that's full day of
20 classroom instruction, the very first part of it spends
21 a great deal of time building a foundation in
22 aerodynamics and how airplanes move through the air and
23 what they do, and the effects of the control surfaces
24 on that movement through the air. And so during that
25 time, there's a great deal of effort and instruction

1 spent on the subject, yes.

2 Q So then you, I assume, feel that many of the
3 pilots who have been through the program have the same
4 understanding of the mechanism by which the rudder
5 produces roll as you just described, verbalized for us?

6 A I think the pilots understand that the rudder
7 can induce roll, yes. I can't speak for what they
8 retain as far as being an aerodynamicist, you know, the
9 exact nature of why that rolls, but I think they know
10 that the rudder can get them roll, I do believe that,
11 yes.

12 Q But do you think there's an understanding,
13 though, that the rudder is not just a power boost for
14 the wheel, that there is a difference in how it
15 produces the roll, or do they think that well, it's
16 like getting a boost on the wheel and you get more
17 effect from a wheel by adding rudder?

18 A I think that their first instinct is to use,
19 if they're trying to roll the aircraft, their first
20 instinct is to use the roll controls, the
21 aileron/spoiler. Do I think that they think that's a
22 power boost for that, no, I don't think that's it. I
23 think most pilots realize it's a secondary effect of
24 what the rudder can do.

25 Q Hold on a second. Also, yesterday, Captain

1 Rockliff testified that it was his understanding or
2 idea that the pilots flew or maneuvered aircraft by
3 feel more than numbers -- I'm paraphrasing what I
4 understood him to say. And I'm sure you heard his
5 testimony. Would you agree with that characterization?

6 A I think we have very precise -- well, I don't
7 think, we do have very precise roll instrumentation in
8 the aircraft, and we have very precise pitch
9 instrumentations in the aircraft. As it relates to
10 rudder, I would agree with his statement that I think
11 pilots do, once again, it was what I spoke to earlier,
12 that they feel a side slip or a yaw acceleration on the
13 aircraft first by feel, and correct for that by feel,
14 because we really don't have any exact instrumentation
15 until you kind of get the airplane back into
16 coordinated flight, and then you can fine tune it with
17 this trapezoidal index we talked about, or the ball in
18 most airplanes, as it's called.

19 Q So I guess at least for the type of maneuvers
20 we're talking about, that certainly by feel or the -- I
21 think he also used words like the gain of experience
22 over time -- that that's how one flies, more than
23 reference to instruments or precise numbers. Is that
24 right?

25 A In particular in reference to an upset, it's

1 more of a procedure. Certainly we can't teach the
2 pilots how it feels to be in an upset. We're not going
3 to take an airplane up there and do that with our
4 pilots. So do they apply that particular procedure by
5 feel? Probably not. They just execute it as the
6 procedure is written. So I don't think they fly that
7 part of it by feel. But I think under normal flight
8 conditions, that they do fly, and particular with yaw
9 accelerations, by feel, yes.

10 Q Thank you. I guess since we've -- since the
11 large part of the yaw or these maneuvers are flown by
12 feel or experience, and I may have understood that the
13 initial kind of instinct response might be the proper
14 procedure, but then the -- in the degree or amount of
15 rudder sort of like Dr. Brenner was talking about, and
16 the amount of rudder to apply and these sort of things
17 is learned by feel. I guess the question would be what
18 opportunities do pilots have to acquire a feel for the
19 roll response of the airplane to the rudder?

20 A Probably not that great of an opportunity.
21 They do, as they fly on a normal basis, maybe have one
22 engine that's producing a little more power than
23 another one and so you'll get some side slip or some
24 yawing in the aircraft, and so you do trim that out,
25 and the other times that they really use the rudder is

1 doing cross wind take off and landings, and I suppose
2 that's really the only time that they get the chance to
3 feel what the rudder does.

4 Q And those examples ... eliminating side slip
5 and actually rolling the airplane?

6 A Yes.

7 Q I think you mentioned that the roll upset
8 training was I guess maybe a total of 15 minutes once
9 every nine months or so. Is -- I guess two questions
10 in one, is that the opportunity for pilots to get a
11 feel for the roll response of the airplane to rudder?
12 And is there anything beyond that -- beyond those --
13 the roll upset training -- where they would have the
14 opportunity to experience the response to the airplane
15 rudder?

16 A In relation to rolling aircraft with rudder?

17 Q Yes.

18 A Obviously, the simulator is very difficult to
19 simulate feel, accelerations, on your body, so that's
20 not a very good tool, but it is the best tool that we
21 have available to simulate those type conditions. For
22 a pilot to experience what the airplane does or how it
23 rolls with use of the rudder, there's just not many
24 opportunities to do that.

25 Q I think the simulator can be used for

1 training for proficiency, I believe is the term used,
2 is that correct, for some maneuvers?

3 A Some maneuvers it is training to proficiency,
4 and it is used for that.

5 Q Like cross wind landings or landings, period.

6 A There's a long list of things such as that,
7 and engine failures, and control malfunctions, and
8 instrument approaches of different types, precision and
9 non-precision, et cetera.

10 Q These train for proficiency maneuvers,
11 there's a large exposure to the maneuvers -- and in
12 these maneuvers, I guess when we say pilots are trained
13 for proficiency, they are trained to acquire a feel for
14 the aircraft for those maneuvers, is that correct?

15 A I don't know that they're trained to the feel
16 of the aircraft or not, but there are some standards of
17 what the FAA has established which those pilots must
18 meet those standards in order to continue on in
19 training, or they receive additional training to meet
20 those standards. I don't know that we have a simulator
21 available to us anywhere in the world that can simulate
22 the feel of an aircraft as it pertains to Gs or et
23 cetera.

24 Q I understand in terms of G loads, but for
25 example, like the landings, I understand that a pilot

1 can, you know, his first landing in a new airplane can
2 be with passengers on board because they -- they have a
3 lot of practice landings in the simulator.

4 A The FAA comes to our facility and they
5 validate and approve our simulator, and in certain
6 maneuvers, of which landing is one of those maneuvers,
7 they validate it and say that the simulator replicates
8 the airplane close enough that your previous statement
9 is correct.

10 Q So my final question then, to kind of bring
11 this into focus, that is comparing the amount of
12 experience pilots have, say, in training for
13 proficiency for landings or other maneuvers, compared
14 to the amount of experience they get to experience the
15 airplane's response in roll, what's the -- what's the
16 difference there? Is there a large quantity of
17 difference in the amount of exposure they get to those
18 two types of maneuvers?

19 A There is. For certain malfunctions and
20 certain maneuvers, we give them a great deal of time in
21 the simulator. In this particular case, with upsets,
22 obviously, it's not a great amount of time. We don't
23 ever expect our pilots to find themselves in an upset,
24 and we hope that they wouldn't. But the simulator, our
25 primary focus on upsets is recognition -- to avert the

1 upset before it ever happens, and then of course, if
2 they do find themselves in an upset, then to apply the
3 procedure. But -- long winded to say no, some of the
4 maneuvers that we conduct in the simulator we spend a
5 great amount of time on, and others we do not.

6 MR. O'CALLAGHAN: Thank you very much, that
7 concludes my questioning.

8 CHAIRMAN CARMODY: Thank you, Mr. O'Callaghan
9 and I know there may be a couple more questions on the
10 technical panel but I think I'll go ahead and have a
11 break now. I think the witnesses need it. I know we
12 need it, and the parties would appreciate it. So let's
13 come back -- before we get up, though, let me make a
14 few announcements, please. When we return, I'm
15 changing the order of the parties because traditionally
16 the last questioner will be those whose witness it is,
17 so at this time American will be last. Why don't we
18 start with Airbus, FAA, Allied Pilots, and American in
19 that order after the break.

20 Two more things: we're going to move some
21 witnesses order. We'd like to move Mr. Rackers (ph),
22 who is currently number 11 to a position between
23 witnesses 15 and 16, which is Kurbit Kubian (ph) and
24 Curlin and 17, Ilkowitz (ph). So this will put Mr.
25 Rackers (ph) between those two. This would put all the

1 composite witnesses in one group, and we understand
2 this is fine with Mr. Rackers (ph). We're also
3 proposing to move Mr. Proctor who is currently 14 to
4 position following witness 6. Now we're looking for
5 Mr. Proctor, but we understand he is prepared. Mr.
6 Proctor is okay with this, so we'll get a new witness
7 list, but I just wanted to make you aware of that.

8 Also, those parties who made -- or those
9 witnesses, rather, who made presentations today and
10 yesterday, please be sure we have copies of those for
11 our hearing record.

12 And last, I understand we have some visitors
13 here from the Korean Air Accident Investigation Board,
14 so we'd like to welcome them, and we're very glad
15 they're joining us. Thank you.

16 Fifteen minutes, please, quarter to eleven.

17 (Whereupon, a 24 minute recess off the record
18 was taken.)

19 CHAIRMAN CARMODY: Let's resume the witnesses
20 from American who had a break, so I trust we're all
21 refreshed, and I understand there were just a couple
22 more questions on the technical panel.

23 CAPTAIN YOUNG: Madam Chairman, the witness,
24 Delvin Young here.

25 CHAIRMAN CARMODY: Yes.

1 CAPTAIN YOUNG: I did want to clarify one
2 line of questioning that Mr. O'Callaghan had asked me
3 about -- use of the rudder and whether the students and
4 the pilots in the simulator could -- if we did any
5 exercises or anything to help them know how much roll
6 control the rudder would give them. And outside of
7 what we've already spoke to, we do an exercise where we
8 do some turns with aileron and spoilers only, and then
9 we do them with rudder and aileron and spoilers to show
10 the effectiveness of those rolls. So I just wanted to
11 clarify that.

12 CHAIRMAN CARMODY: Alright, thank you. Now,
13 the technical panel, was it Mr. Jouniaux has some
14 questions? Please proceed.

15 MR. JOUNIAUX: Thank you, Madam Chairman. So
16 I would like to come back and go a bit further to
17 address the actual simulator training exercises and
18 techniques and the feel the pilots can have from that,
19 which -- so which operated to the crews, especially
20 with the wake turbulence,, and for that I will refer to
21 the Exhibit 2-B and in particular, page 12, 17 and 19.

22 So the interviews in the Exhibit are with American
23 pilots -- airline pilots who had recently followed the
24 AAMP program.

25 First, I would like to refer to the -- to

1 page 17, which -- yes. I can read it, a small
2 quotation. It says, "wake turbulence" -- one of the
3 pilots says, "wake turbulence is used in the simulator
4 to lead to an upset situation". So my question first
5 go to Mr. Ghoshal --

6 CAPTAIN YOUNG: And you're on page 17, is
7 that correct?

8 MR. JOUNIAUX: Page 17, correct.

9 CAPTAIN YOUNG: Okay.

10 QUESTIONING OF MR. GHOSHAL

11 BY MR. JOUNIAUX:

12 Q So my question to Mr. Ghoshal will be, does
13 this wake turbulence scenario combine the pitch and
14 roll event you describe or just one of those?

15 A As I explained earlier, we do not have wake
16 turbulence as such. We have two separate scenarios,
17 one for pitch upset and one for roll upset. They are
18 separate.

19 Q Yes, but does -- when this pilot refers to
20 wake turbulence, does they mean that they are pitch and
21 roll at the same time?

22 A You cannot have two at the same time, so I
23 don't know what he means, really.

24 CAPTAIN YOUNG: And I will further explain
25 that is that there is a button on the instructor's

1 panel, or there was at the time, to either select
2 either the pitch maneuver or the roll maneuver. Now
3 the roll maneuver, depending on how the pilot reacted,
4 if it did get greater than 90 degrees, it could end up
5 in a nose low condition.

6 QUESTIONING OF CAPTAIN YOUNG

7 BY MR. JOUNIAUX:

8 Q I will refer to page 12, then, it's the sixth
9 paragraph. It says "wake turbulence training includes
10 simulator training of some extreme unusual attitudes
11 for wake turbulence encounters. For example, a nose
12 down roll to an inverted attitude." And the next
13 paragraph, about wake turbulence and this pilot
14 mentioned that "the simulator ride included an
15 unsuspected unusual nose high attitude" and then he
16 describes the recovery, so that leads me -- "Recovery
17 was to add power and ... relative to the horizon."

18 So this leads me to the next question, so
19 from this interview, it seems that the feedback it
20 seems like we have from the pilot is very different
21 from what was presented in the AAMP ground course that
22 say that for the wake turbulence has limited upsets on
23 aircraft, but this it seems that these pilots associate
24 wake turbulence with large upset. And the second is
25 said in the ground course that in high pitch situation you

1 train pilots to use aileron to roll the aircraft first
2 towards the horizon. Here it seems that the
3 understanding of the pilot is to use rudder to go
4 towards the horizon. What are your comments about
5 that?

6 Q The wake turbulence here -- and as I said
7 that for the rolling maneuver in particular, we do not
8 introduce any other type of aircraft malfunctions like
9 hard over rudder, so, and the weather -- the instructor
10 generally sets the weather fairly clear. So, to just
11 be flying along and all of a sudden it just goes out of
12 control or it goes into some type of upset maneuver,
13 what the instructors do to kind of set it up is that
14 they -- they don't always, but I'm sure many of them do
15 say you're following a heavy jet, some use actually the
16 747, and you're cleared for takeoff and then they go
17 and execute the roll maneuver.

18 Now -- and I know there's a lot of talk right
19 now, certainly, about this roll maneuver exercise. Our
20 objectives were to get them past 90 degrees, 90 degrees
21 or greater is the exact of what we were trying to do,
22 because of some accidents. There are several ways you
23 can do that. You can have the instructor fly it there
24 and freeze the simulator and put him there. You could
25 have the other pilot put their head down and have the

1 pilot not flying put it there, or have the pilot flying
2 close their eyes and give it some turns and different
3 things, and as a standards manager, and all along as an
4 instructor, I'm always working with trying to
5 standardize our training. We have -- at one time we
6 had nearly 15,000 pilots -- 14,000 and some pilots is
7 what it was, and so standardization is a huge issue.
8 And so to -- we felt that this was the best way to
9 standardize the training to make sure everyone got
10 exactly the same thing, and we chose this method to put
11 them in that particular upset. The fact that the
12 instructors used the words wake turbulence or whatever
13 -- and I don't think any pilot out there thinks that --
14 I mean they experience wake turbulence all the time.
15 I'm not for sure that a pilot thinks because they get
16 into wake turbulence they're going to end up upside
17 down. I don't think this training predisposes them to
18 that.

19 Q I mention that because we have around six
20 interviews referring to the same scenario for upset
21 exercise.

22 A Agreed, and I think that most of the
23 instructors probably do say that, hey you're clear for
24 takeoff, you're following a heavy jet or whatever it
25 might be.

1 Q This is my last question, in the light of
2 these statements, can you describe what type of
3 guidelines were given to the instructors before they
4 delivered this training program?

5 A There was a -- the instruction that you saw
6 before, the instructor gave training to all our
7 instructors -- ground school check airmen as well as
8 numerous other instructors, not only from American
9 Airlines, but from several airlines and agencies --
10 FAA, NTSB -- many in this room today have received that
11 instruction. And then, obviously that one instructor,
12 Captain Vandenberg, could not give all -- all of our --
13 every single pilot instruction in the simulator, so it
14 cascaded down to them in the simulator. Does it make
15 sense.

16 Q Do you use any guideline -- written or
17 something given to the instructors to teach these kinds
18 of exercises?

19 A The guideline is the procedure out of the
20 operating manual for nose high and nose low, and so
21 that's really the guideline. As far as the maneuvers,
22 prior to 587, we had these preprogrammed buttons so we
23 have a worksheet that requires the instructor to
24 complete, and on one of those -- on the worksheet is
25 these upset maneuvers, and so the instructor would just

1 go to that page on the instructor panel in the
2 simulator and select either a pitch or a roll maneuver.

3 Q And how do they teach to recover from this
4 situation?

5 A They teach from basically the procedure, and
6 if you follow the procedure step by step right down the
7 line, it's an effective tool for how we recover from
8 these upsets.

9 MR. JOUNIAUX: Thank you, Captain Young.

10 CHAIRMAN CARMODY: Thank you. Anything else
11 from the technical panel. Alright, in that case we'll
12 move to the parties and start with Airbus. Any
13 questions of the witness?

14 DR. LAUBER: Thank you, Madam Chairman. Yes,
15 I have several questions I'd like to ask Captain Young
16 and Mr. Ghoshal.

17 QUESTIONING OF CAPTAIN YOUNG

18 BY DR. LAUBER:

19 Q Captain Young, yesterday Captain Rockliff
20 testified that -- with regard to AAMP -- it was his
21 opinion that in general, and in many ways the program
22 was very good, and in fact, I think he commended
23 American for taking the action to put such a program in
24 place. But just to make sure it isn't the concept of
25 AAMP that is of concern, but we do have some specific

1 concerns, as he stated, about what was taught and what
2 was learned with regard to use of rudder, and how that
3 ties into simulation, and how that ties into wake
4 vortex recovery procedures, and how it might be related
5 to the accident. So that's what I want to explore with
6 you a little bit further in my questioning.

7 First of all, with regard to the timing, do
8 you recall when Mr. Molin took the AAMP program? When
9 he took the course?

10 A Yes, sir, March of 1997.

11 Q And you testified earlier that changes were
12 made to AAMP with regard to the -- to what was taught
13 regarding rudder use when, Captain Young?

14 A No, I didn't testify that changes were made
15 to the content of the program. I said the supplemental
16 material, which was the AAMP booklet, workbook, that
17 bullet statements in there, that the wording had been
18 changed to clarify what was already being taught in the
19 course.

20 Q And specifically it had to do with
21 coordinated rudders, is that correct?

22 A It added coordinated rudder, and there have
23 been other changes over time.

24 Q So that coordinated rudder as it's now used
25 in AAMP is the conventional definition of coordinated

1 rudder, is that basically correct?

2 A Well, I know on the video clip there, Captain
3 Vandenberg said that today that's what he was talking
4 about, coordinated rudder, and I think I've already
5 answered what I meant by -- personally, what I meant by
6 coordinated rudder. What Captain Vandenberg was
7 speaking to was a very unique situation that involved
8 high angles of attack, and what he was talking about
9 there.

10 Q In any event, those changes and the warnings,
11 by the way, that were added to the video, came after
12 Mr. Molin took AAMP, is that correct? Changes to the
13 supplemental material and the video?

14 A The clarification of what was already being
15 taught in the class came -- I mean it's evolved over
16 the years and that tag on the end of the video which
17 was distributed in December of 1997 to every American
18 Airlines pilot -- that tag was just to reiterate and to
19 restate what had already been said in the program, as a
20 result of the feedback from the four signatories on the
21 letter there of August of 1997.

22 Q With the added caveat with regard to use of
23 rudder. That was the tag on at the end.

24 A Well, there were other tags ons..

25 Q Okay, well, do we know whether Mr. Molin

1 actually ever looked at the video, saw the video?

2 A No, sir, I have no way of knowing that.

3 Q And in fact, his first exposure to AAMP was
4 March of '97, he saw the full blown high test version,
5 basically, is that correct?

6 A Yes, sir, he saw the full eight hour ground
7 school.

8 Q And when would he have had his simulator
9 exercise relative to AAMP?

10 A The simulator exercise.

11 Q Yes, when would he have experienced the roll
12 upset recovery to be specific, or the wake vortex
13 recovery procedure in the simulator? When would he
14 have had his first exposure to that?

15 A It would have been during his normal
16 recurrent training or if he was upgrading on an
17 aircraft or transitioning to a new aircraft, he would
18 have had the AAMP maneuvers or the AAMP training then
19 in the simulator.

20 Q Would he --

21 A Wait -- vortex training -- I just want to
22 make that clear.

23 Q Was he in transition training during this
24 period?

25 A No, sir, I don't think so.

1 Q Are you familiar with the law of primacy as a
2 training person? Does that mean anything to you?

3 A I've heard of it one other time as they spoke
4 during -- for this investigation, or during this
5 investigation I had heard that you had spoke of it at
6 one of the meetings. And that's the only time.

7 Q Do you have a working understanding of what
8 it means or do you have an understanding or a
9 definition of what the law of primacy is about?

10 A I am not a psychologist, nor a psychiatrist,
11 so --

12 Q So you don't recognize that the basic
13 principle is that people tend to remember best that
14 which they hear first?

15 A I know basically that pilots have a pretty
16 short attention span, and so if you're going to say
17 something important you'd better get it out early.

18 Q Right. Can't argue with that, Captain Young.
19 Can't argue with that. I'm interested in what appear
20 to be different -- I'm trying to understand exactly
21 what was and what wasn't taught with regard to use of
22 rudders, and I want to start with this notion of
23 coordinated rudder. Could you look at Exhibit 2-B,
24 page 45, please?

25 A Yes, sir.

1 Q Okay, specifically, page 45 if I didn't say
2 that, sorry.

3 A I have it.

4 Q And starting right at the top of the page.
5 This is an interview of Captain Landry. First of all,
6 who is Captain Landry?

7 A Captain Landry, at the time of this interview
8 was the managing director of training for American
9 Airlines.

10 Q Managing director of training. Okay. Could
11 you -- could you take the second paragraph, and just
12 read for us, please, what Captain Landry said. First
13 two paragraphs.

14 A The first two paragraphs?

15 Q Yes.

16 A From Captain Landry, and let me see what the
17 question was.

18 Q I'm sorry, we have a discrepancy in the page
19 here. What I have as Exhibit 2-B circled page 45,
20 okay, let's go to the top -- that's still wrong, it
21 doesn't -- I don't know how to resolve it here because
22 this is the Exhibits that we have, 2-B, 45, Captain
23 Landry interview, and it's Mr. Ivey doing the
24 questioning -- it's page 284 of the original operations
25 group interview notes if you have that. Try page 42.

1 I'm told -- yes.

2 A I think I have what you want here in front of
3 me. I'm not for sure they can display it up there.

4 Q Okay, do you have the paragraph that begins
5 "If you're talking about -- well, I think what Warren
6 said..."?

7 A Yes, I do.

8 Q Okay, would you read that for us, please.

9 A It says, "If you're talking about -- what --
10 well, I think Warren said it well in his lecture when
11 he talked about coordinated rudder. I think he gave a
12 great caveat right off the bat and said that when he
13 talks about coordinated rudder, he's talking about
14 rudder in the same direction as the ailerons."

15 Q So would you continue down in the second
16 paragraph, just read the last sentence in the second
17 paragraph, please.

18 A The last sentence in the second paragraph is,
19 "I think he gave a great caveat right off the bat and
20 said that --

21 Q No, I'm sorry, in the -- down there, the last
22 sentence --

23 A I'm not sure where there is, can you specify?

24 Q Where the arrow is on the display up there.
25 "So my impression of what Warren has been saying ..."

1 A "So my impression of what Warren has been
2 saying about coordinated rudder has to do with rudder
3 in the direction that you want to roll, i.e., the same
4 direction that the ailerons are going."

5 Q Okay, in that context, I know you played for
6 us a number of excerpts from the video that had been
7 made of Captain Vandenberg's lecture, there are some
8 segments that you didn't show. In one of them he says,
9 with reference to the recovery from an inverted nose
10 low attitude, he says, "I'm going to tell you to put in
11 coordinated rudder, put it fully in, fully, all of it,
12 right now. As many of you know, the rudder in this
13 portion of the roll becomes what acrobatic pilots call
14 top rudder" -- and he goes on to talk about the idea
15 that somehow during the recovery from an inverted turn,
16 the little bit of rudder back there is going to hold
17 the nose of this transport sized airplane up in the
18 air.

19 But in any event, he goes on to say, talk
20 about "When you pull back, what goes up? Angle of
21 attack. When angle of attack goes up, what rolls the
22 plane? Rudder. Exactly, and that's rudder all the way
23 in and it will whack. It will try to snap roll. That's
24 fine. Just neutralize the rudders real quick."

25 Do you have any reaction, first of all, to

1 any of what Captain Vandenberg says in the video in
2 this context?

3 A In the context of top rudder, that's a very,
4 very specific, unique situation. I think getting a
5 transport category airplane upside down is very unique
6 in itself and it is an extreme condition that it needs
7 immediate attention. I don't think there's any pilot
8 in here that disagrees with that. And specifically,
9 talking about top rudder, if you're concerned about the
10 nose dropping through and getting nose low, then top
11 rudder may help you preserve your nose up to assist you
12 in this recovery, as it pertains to top rudder there.

13 Q But would you agree that his description
14 about how to do it, right now, fully, implies certain
15 aggressive input on the rudder?

16 A Would it imply aggressive? I mean as you
17 state it right there, I would say yes, but to further
18 that, prior to this accident, as a pilot, I didn't know
19 you couldn't do that.

20 Q You couldn't do what? Sorry.

21 A Be aggressive with the controls at the speed
22 that we're talking about, when you're slow and a high
23 angle of attack.

24 Q I don't know what's in the record that says
25 you can't be aggressive with the rudder with angles --

1 any normal flight angle of attack. I don't know where
2 that comes from. You might want to share that. I
3 don't understand what your reference is to you weren't
4 aware of a prohibition about the aggressive use of
5 rudder in flight.

6 A You made reference to whether I thought this
7 was aggressive and whether that was appropriate or not.

8 Q Right.

9 A Prior to this accident, I had never heard
10 anyone speak of, or never had -- we had never had
11 official communication with the manufacturers about the
12 aggressive use of rudders.

13 Q Well, we, yesterday, spent some time going
14 over the record with regard to written communications
15 on that and I won't pursue that further here. The
16 point is, with regard to what Captain Vandenberg taught
17 with regard to rudder, in this context as we just
18 discussed it, is that basically he was advocating open
19 loop control of the rudder. Would you agree with that,
20 based on the discussion we had on open and closed loop
21 concept yesterday?

22 A You're going to have to refresh my memory
23 about open loop/closed loop -- exactly what you mean by
24 open loop.

25 Q In closed loop control, you're using the

1 control to achieve some desired aircraft performance
2 objective. Maybe a yaw rate, it may be a bank angle.
3 In open loop control, you're basically going to the
4 stops, if you want, there's no specific performance
5 objective in mind other than moving the control to some
6 specified position. Based on what Captain Vandenberg
7 has described as coordinated rudder, isn't that an
8 instance of open loop control that he's advocating with
9 regard to rudder?

10 A In what you just said in describing open
11 loop, the objective in a very special case of where
12 you're concerned about getting the nose excessively
13 low, the use of -- if you will -- and I'm not that
14 familiar with open loop/closed loop controls -- but in
15 the context that you just explained, I would say that
16 he did want to go to full control of the rudder, or to
17 the stops on the rudder to help hold the nose up so
18 that it did not get excessively low.

19 Q Fully and quickly was the way he advocated it
20 in the video. His words.

21 A I don't have that available to me right now,
22 if you say so, then I will trust your words.

23

24

25 QUESTIONING OF MR. GHOSHAL

1 BY DR. LAUBER:

2 Q I'd like to pursue the issue of simulation
3 and the role that it played in all of this, including
4 how rudder was taught and the issues of the roll
5 maneuver and the function button that we've heard Mr.
6 Ghoshal describe for us. Spent some time talking about
7 the fidelity of simulation based on data packages
8 provided by simulator manufacturers, is that -- that's
9 part of what we spent time talking about. And the
10 focus, I think, of your comments, Mr. Ghoshal, had to
11 do with the aerodynamic part of the simulation, isn't
12 that correct?

13 A All the systems, really. Not just
14 aerodynamics -- hydraulics, pneumatics, auto pilot --
15 everything comes from the aircraft manufacturer.

16 Q Correct, as far as they can be replicated in
17 the cockpit, correct?

18 A Yes.

19 Q So aerodynamic data would show up in the form
20 of changes in aircraft performance, instrument
21 readings, attitudes, air speed, altitudes, and similar
22 kinds of things, right?

23 A Yes.

24 Q But in the real world, in the real airplane,
25 what's correlated with any kind of motion of the

1 airplane, are also accelerations experienced by the
2 pilot as he's strapped in his or her seat in the
3 airplane, isn't that correct?

4 A I'm really not a pilot, but yes, there are
5 simulator limitations for acceleration detection, if
6 that's what you're getting at.

7 Q And are those capable of replicating the full
8 envelope of accelerations that could be experienced by
9 the pilot in flight?

10 A There are limitations in flight simulators
11 where both translational and rotational accelerations
12 cannot be maintained.

13 Q In fact, basically because of the limited
14 motion capability of simulator platforms, all you can
15 really provide are the onset cues, the onset
16 acceleration cues, and you can't sustain any lateral,
17 vertical or longitudinal G forces for any period of
18 time, is that correct?

19 A Yes.

20 FURTHER QUESTIONING OF CAPTAIN YOUNG

21 BY DR. LAUBER:

22 Q Captain Young, as a pilot, aren't those
23 forces of particular importance in helping the pilot
24 determine which direction his airplane is going and
25 what his attitude is in energy state, and similar kinds

1 of things? Isn't that an important source of
2 information for the pilot?

3 A It can be an important source of information,
4 but we've all probably experienced vertigo, certainly
5 in jet aircraft, so those are not always the only cues
6 that you get, and -- and there's no doubt, when we
7 train pilots, there are simulator limitations where it
8 is not 100 percent replication of the aircraft. There
9 has not been one built on this earth that is 100
10 percent replication of the aircraft. So, of course
11 it's not going to replicate it exactly.

12 Q I'm glad you brought up the question of
13 vertigo because I was going to ask you if you've ever
14 personally experienced vertigo, or "the leans", or it
15 goes by a number of common terms among pilots. You
16 were a military pilot at one time, I believe, is that
17 correct?

18 A You are correct.

19 Q And you have or have not experienced vertigo?

20 A I have.

21 Q Spatial disorientation?

22 A I have.

23 Q And generally, what are the consequences of
24 that?

25 A Consequences?

1 Q Right, what are -- how does it affect you in
2 your ability to control the airplane?

3 A If you get "the leans" as you mentioned, or
4 vertigo, you're taught to get back on the instruments
5 and look at the instruments to regain situational
6 awareness, and if you will, repage your own personal
7 gyros.

8 Q So the point is that the precipitating event
9 for vertigo or spatial disorientation is often a
10 conflict between what the pilot is seeing and what the
11 pilot is experiencing through the vestibular system
12 that senses acceleration --

13 CHAIRMAN CARMODY: Excuse me, Dr. Lauber, I
14 wonder if you might refine your questions a little bit.
15 You're doing a lot of explaining and analyzing and the
16 witness is just being asked to agree or disagree. I'd
17 prefer you ask things he can actually comment on.

18 DR. LAUBER: Okay, fair enough, Madam
19 Chairman, I'll do that.

20 BY DR. LAUBER:

21 Q You understand what causes vertigo?

22 CAPTAIN PITTS: Madam Chairman, if I might,
23 this line of questioning -- this airplane was --

24 CHAIRMAN CARMODY: No, I'm sorry. It's not
25 appropriate for you to object to anyone questioning. I

1 did point out that I think Dr. Lauber needs to refine
2 his questions and not testify himself, but as we agreed
3 at the prehearing conference, objections are not part
4 of this proceeding. This is an informal proceeding,
5 not a courtroom, so we can talk at the break if you
6 have any specific concerns.

7 CAPTAIN PITTS: Thank you, Madam Chairman.

8 CHAIRMAN CARMODY: Thank you.

9 BY DR. LAUBER:

10 Q Do you understand what causes vertigo?

11 A I understand, I had military training in what
12 causes vertigo, to a certain extent. I am not a
13 medical doctor, but my own personal experience with
14 vertigo, it generally centered around, usually,
15 weather, that there was no clear horizon, or you were
16 in the weather to where you were depending on the
17 instruments. Generally what I found was that, kind of,
18 if you will, marginal weather was worse than very bad
19 weather, because in very bad weather, you stayed on the
20 instruments all the time, so you maintained your
21 situational awareness. In good weather you had the sky
22 and the ground, and the horizon, and some things --
23 visual cues outside, so my own personal experience is
24 primarily during marginal weather was when vertigo was
25 experienced.

1 Q Do you think it's possible that a pilot who's
2 only experienced extreme attitudes, inverted attitudes
3 in a transport carrier airplane, for example, in a
4 simulator might be surprised or even disoriented by the
5 different forces and accelerations that he or she would
6 experience when that same situation occurs in an actual
7 airplane?

8 A I think the forces experienced in an actual
9 airplane, outside of the normal flight envelope where
10 we normally fly, you know, with a very small amount of
11 positive and less than one G, forces outside of that, I
12 think, would cause a pilot to -- I think they would be
13 -- I don't know if I would use the word surprised, I'm
14 not for sure that's an accurate term, but it would be
15 unfamiliar.

16 Q And that sometimes causes surprise, is that -
17 - and that's your testimony, right?

18 A Are you telling me, or are you ==

19 CHAIRMAN CARMODY: Dr. Lauber, ask the
20 witness, please.

21 DR. LAUBER: I'm sorry.

22 BY DR. LAUBER:

23 Q Well, let's move on to another area here.
24 And we're still dealing with the issue of simulator
25 fidelity and how it might affect the lessons that

1 trainees take away from the simulator. Could you show
2 Exhibit 2-B, and I hope the page numbering is correct -
3 - the page I have is page 64, circle page 64. Now this
4 is correct, right.

5 I'd like to -- we're talking here, this is an
6 interview with Mr. Cook. Down in the middle, Mr. Cook
7 is being interviewed by Mr. Ivey and would you read the
8 paragraph that begins, "And I think what I see.."

9 A "And I think what I see is most pilots put in
10 the correct amount of bank angle and rudder that I
11 think the airplane would require, and then I have to --
12 I'm sitting in the instructor's seat, which is right
13 behind the Captain, and I just, in a very calm voice
14 tell them, more rudder, more rudder. And then I go
15 through again, that I don't believe that the aircraft
16 without some type of structural problem would require
17 that much rudder."

18 Q Would you turn next to page 67, same Exhibit?
19 And who by the way, is Mr. Cook?

20 A Mr. Cook is one of our simulator pilots for
21 American Airlines.

22 Q Page 67, and it's Mr. Cook, "In the
23 simulator" it begins. Would you read that for us,
24 please?

25 A "In the simulator, it's difficult, I believe.

1 In the airplane, it -- I think it's easy to determine
2 the amount of rudder necessary to keep the turn
3 coordinated. We all learned it when we first started
4 flying."

5 Q Okay, and could we next go to page 68,
6 please? Okay, on page 68, Mr. Cook -- "The airbus
7 requires more rudder" -- see that right down there near
8 the bottom, right of -- kind of in the middle?

9 A "The airbus requires"?

10 Q Yes.

11 A "The airbus requires more rudder -- the
12 simulator -- now that's only during the pitch up
13 maneuver, the way it's programmed. If they get the
14 nose high in another situation, then it reacts more
15 like, I believe, the aircraft would."

16 Q Doesn't it seem in all of these that --
17 what's your take away from this with regard to Mr.
18 Cook's view about the fidelity or the faithfulness of
19 the simulator and the ability to deal with the
20 situations or replicate the situations that are
21 involved in this training scenario?

22 A I think Mr. Cook thinks there's some
23 limitations to the simulator.

24 Q And with regard to the simulator and
25 simulator data, Mr. Ghoshal you testified that the data

1 package that you use is provided by the manufacturers,
2 and you indicated -- one of you, it may have been you,
3 Captain Young, indicated in your testimony that you had
4 invited Airbus and the others to review the alpha and
5 beta data with regard to that simulation, is that -- do
6 I remember that correctly?

7 A Yes, sir.

8 Q In what form was that invitation extended to
9 Airbus?

10 A In the response letter to the August 1997
11 letter, there was a statement in there by our Vice
12 President of Flight at the time, in inviting the
13 manufacturers to review -- or actually, the
14 manufacturers and the FAA -- all four signatories -- to
15 review the simulator data, and the exercises that we
16 were performing at the time for AAMP.

17 Q Could we provide the witness with Exhibit 2-
18 C, please, which is the letter in question.

19 CHAIRMAN CARMODY: Dr. Lauber, we did discuss
20 this issue extensively yesterday as I recall, so I hope
21 we're not going --

22 DR. LAUBER: Not this specific issue, Madam
23 Chairman.

24 CHAIRMAN CARMODY: Alright. Well, let's not
25 -- I would urge you to read the section you're

1 concerned about rather than have the witness read all
2 of this information.

3 DR. LAUBER: Well, I -- okay.

4 CHAIRMAN CARMODY: Thank you.

5 BY DR. LAUBER:

6 Q Do you have page nine in front of you?

7 A I'm looking at page nine, yes, sir.

8 Q Okay, in about the middle, it's the paragraph
9 entitled "Use of simulators" and it begins, "The AAMP
10 program" -- the very last sentence in that paragraph
11 says, "On your next visit to our flight academy, we
12 will be pleased to show you the beta readouts during
13 this event." Is that the invitation that you're
14 referring to, the reference?

15 A Yes, sir, and you have to understand that. I
16 know these letters have been suggested that this was
17 the only communication going on between the
18 manufacturers and the users and all the other airlines.
19 That is clearly not the case, that there was a lot of
20 dialogue -- phone calls, letters, e-mails for sure, and
21 there was a lot of dialogue because this was an
22 industry concern at the time, and as I've heard in
23 other statements, we didn't know the exact answer --
24 and I'm saying we as an industry, and we were trying to
25 prevent what it -- there was a history of loss of

1 control accidents. So -- yes, that was the invitation,
2 but I am positive that there were other invitations
3 afforded to the manufacturers through conversations, et
4 cetera.

5 CHAIRMAN CARMODY: Excuse me, Dr. Lauber, I
6 beg to differ, we did discuss this yesterday because my
7 colleagues had highlighted that very section. So the
8 point's been made. I think we need to move on to
9 things we don't know already, and the time is getting
10 late and this is our --

11 DR. LAUBER: Okay, I understand.

12 CHAIRMAN CARMODY: -- fifth witness, so let's
13 move please. Anything new, please, and if not, we'll
14 pass to the next party. Thank you.

15 BY DR. LAUBER:

16 Q With regard to the AAMP handout, Captain
17 Young, you had a slide that you had put up that showed
18 -- you said an F-100 basically, sized airplane, behind
19 a larger aircraft.

20 A Yes, sir.

21 Q That is Exhibit 2-D, page 55.

22 A Yes, sir.

23 Q Would you go -- could we put that up on the
24 screen please? The Exhibit handout we have is not page
25 numbered, it just says page 55. It's page 55 from the

1 original AAMP booklet.

2 CHAIRMAN CARMODY: Is this the correct
3 Exhibit that's on the screen now?

4 DR. LAUBER: I don't see one, ma'am.

5 CHAIRMAN CARMODY: There.

6 DR. LAUBER: That is the correct one.

7 CHAIRMAN CARMODY: Alright.

8 BY DR. LAUBER:

9 Q Captain Young, is there a difference between
10 this diagram and the one you had shown earlier?

11 A Yes, there is.

12 Q And what is that difference?

13 A The difference is -- the generating aircraft
14 is still the same, the MD-11, the McDonnell Douglas 11,
15 but the aircraft is further inverted to 120 degrees of
16 bank as opposed to what appeared to be 45 on the
17 earlier one.

18 Q Are you aware of any upsets involving a
19 heavy transport like the A300-600 that takes -- took
20 the airplane to extreme bank angle such as depicted
21 here?

22 A I am not personally aware of any upsets of an
23 A300 that took into extreme angles, but -- and you have
24 to understand, and I mentioned this early in my
25 testimony, that wake turbulence -- that this was a --

1 the AAMP was a generic program that talked about -- to
2 all of our aircraft, which at the time, we were very
3 concerned -- we had some aircraft that had shorter wing
4 spans that were susceptible to upsets by large
5 aircraft, and specifically the Super 80 and the Fokker.

6 But we never suggested that a wake turbulence would
7 absolutely put you in an upset condition.

8 Q But did you tailor AAMP at all to specific
9 airplanes, take into account characteristics, differing
10 characteristics such as the one you just talked about?

11 A The -- for wake turbulence? No, sir. There
12 was a generic discussion during the ground school
13 presentation.

14 Q Mr. Ghoshal, with regard to the data package
15 that comes from the manufacturers that provides the
16 basis for your simulation, with regard to the
17 modifications that you made, that is basically the
18 inhibition of all rolling moments as we understood it,
19 and as you described it, was Airbus -- did Airbus --
20 were we asked to provide or did we provide any data
21 with reference to that specific modification?

22 MR. GHOSHAL: No, sir. Does not need it.

23 BY DR. LAUBER:

24 Q Captain Young, has anyone told you in any of
25 your base visits, or any of the other contacts that

1 you've had subsequent to the accident involving flight
2 587, that if in fact the pilots of 587 had -- did make
3 full rudder input to recover from upset, they only
4 would have been doing what all American pilots had been
5 taught in AAMP. Has anybody ever said that to you?

6 A Not to my knowledge. AAMP spoke specifically
7 to high angle attack in reference to the rudder. As I
8 stated earlier, I don't think airline pilots, or pilots
9 of transport category airplanes are just going to
10 categorically put in the rudder unless there is a
11 reason for that, i.e., a side slip or a yaw
12 acceleration. I think they will try and correct that
13 situation, the yaw or the side slip, back to a zero
14 side slip condition, back to coordinated flight, if you
15 will.

16 DR. LAUBER: Thank you. Madam Chairman, I
17 have no further questions.

18 CHAIRMAN CARMODY: Thank you, I'll move to
19 the FAA, Mr. Donner, please.

20 QUESTIONING OF CAPTAIN YOUNG

21 BY MR. DONNER:

22 Q Thank you. I have just a couple of questions
23 for Captain Young. Sir, you mentioned, I believe, that
24 the flight controls of the A300 were -- I think your
25 words were -- more powerful than other aircraft in the

1 fleet. Is that correct? Did I hear that?

2 A No, it wasn't exactly. I said that when you
3 fly the aircraft, the controls feel powerful and the
4 way I described that is when you make a turn or
5 something, it takes a very small amount to get a large
6 or a reasonable output, if you will. If you put in a
7 small amount of aileron, you'll get some roll
8 associated with that, and it takes a small amount, that
9 you feel that if you would put in a great amount, you
10 would get a large rolling moment.

11 Q Would more sensitive be an appropriate term
12 for that?

13 A Possibly.

14 Q My real question is, did you find in your
15 experience in the training department that your pilots
16 had a difficult time adjusting to this -- whatever we
17 should call it -- power or sensitivity?

18 A No, I haven't seen that nor have the check
19 airmen or instructors that I have working for me, have
20 they indicated that pilots have had a problem
21 transitioning from the simulator to the aircraft in
22 that respect.

23 Q Thank you. You mentioned the turn
24 demonstrations where you used aileron and spoiler, and
25 then you did it again with aileron, spoiler and rudder.

1 What speeds were used for those demonstrations?

2 A I'd have to look at our training program, but
3 it was relatively slow speeds with high angle of
4 attack. I'm not exactly sure of an exact speed.

5 Q It was a high angle of attack maneuver?

6 A Yes, sir, it was relatively slow speed.

7 Q Thank you. In light of what we've said today
8 and the mention that the simulator setup is to mention
9 that you're following a large -- a heavy aircraft to
10 prepare for this maneuver of the upset in your
11 simulator, are you considering changing the words on
12 that or creating a different scenario in light of what
13 you heard here?

14 A The words on the instructor's panel say roll
15 maneuver, and we took that right out of the HBAT, the
16 9510, and the same thing with the pitch maneuver --
17 that's what the instructor selects. Do we talk more
18 about that? Yes, we do because we understand more now
19 than we did a year ago about rudder and sensitivity of
20 rudder and rudder reversals and doublets et cetera.

21 Q No, I meant more specifically your setting up
22 the crew to anticipate a wake turbulence encounter, and
23 then you give them a resulting upset. Are you
24 considering making any changes to that scenario?

25 A Well, we have changed it right now. The

1 preprogrammed buttons that we disabled after the
2 accident, we disabled them from the instructor, and so
3 we're in the process, as I mentioned earlier, there's
4 several ways you can set up an upset maneuver, and we
5 had chosen, and we thought for standardization reasons
6 as well as others, that the preprogrammed buttons were
7 the best method. We're in the process of evaluating
8 another method now, of which they wouldn't have wake
9 turbulence because what we do is reverted to kind of an
10 old military way of doing it, of having one pilot close
11 their eyes and put their head down, and the other pilot
12 put them in that maneuver. At the end of some of this
13 we will determine which is the best way. What we're
14 concerned with in that is standardization, because we
15 want every single pilot to get a very standardized
16 training as they go through and if one -- and in the
17 method we're using now, if the pilot didn't -- you
18 can't always -- how should I say this -- you can't
19 always assure that every pilot gets exactly the same
20 thing.

21 Q Understand, and I think I'm still not making
22 my point.

23 A I'm sorry.

24 Q My point is that you're preparing your crew
25 for a wake turbulence encounter by saying he's

1 following a heavy jet.

2 A We don't do that now. That's what I'm
3 saying.

4 Q You don't do that now? You don't use those
5 words any more?

6 A No, because the preprogrammed buttons have
7 been removed from the instructor's panel so -- and
8 there's no way to really induce it other than flying it
9 into an unusual attitude or an upset procedure.

10 Q Okay. Another subject. Mr. Ghoshal spoke to
11 the fact that the FAA has not required any changes to
12 the simulator software since this accident. Have you
13 become aware of any changes the FAA has requested or
14 suggested since the accident, in your training
15 programs, on the use of rudder? And I'm speaking
16 specifically at FAA notice A428.

17 A I don't have that in front of me, so I'm not
18 sure what it says.

19 Q I'll be happy to provide a copy at the break.
20 Thank you.

21 MR. DONNER: That's all the questions I have,
22 thank you.

23 CHAIRMAN CARMODY: Alright, thank you, Mr.
24 Donner. Moving on to Allied Pilots, Captain Pitts, any
25 questions?

1 CAPTAIN PITTS: Yes, ma'am, thank you.

2 QUESTIONING OF CAPTAIN YOUNG

3 BY CAPTAIN PITTS:

4 Q Good morning, Captain Young.

5 A Good morning.

6 Q Sir, do you think that vertigo had anything
7 to do with the American Airlines 587 accident?

8 A As I said, I'm not a doctor, but my
9 experience in the military with vertigo, as I
10 understand and looked at the weather, it was fairly
11 clear with discernable horizon, and I would not think
12 that would have been a factor.

13 Q Thank you.

14 A And by that, I mean vertigo.

15 Q I'm going to use a model, ma'am, to help with
16 this depiction here that we were talking about a minute
17 ago. Now we're talking about an inverted situation,
18 nose low, and we were talking about the use of top
19 rudder -- Dr. Lauber mentioned this, so I'll use the
20 model for this. Was 587 ever in a nose low, inverted
21 position prior to loss of the tail?

22 A Not that I've seen on any data at all.

23 Q Do you think that the concept of top rudder
24 had anything to do with the 587 accident?

25 A No, sir.

1 Q Now, in terms of how we're trying -- if we
2 were to find a transport category aircraft in this
3 position, would this be a normal, abnormal or emergency
4 condition?

5 A I would consider it an emergency condition.

6 Q Alright, sir. And in an emergency situation,
7 I'm going to ask you to think back on your Air Force
8 training and what you're training to now. What's the
9 first step in an emergency situation?

10 A First of all, you have to recognize it. And
11 then maintain aircraft control.

12 Q Yes, sir. And would it be every pilot's
13 expectation in maintaining aircraft control that he
14 could use all three axes of his aircraft to in fact
15 right it up?

16 A I think every pilot would use primary
17 controls to always fly the aircraft.

18 Q Thank you. And was this the condition that
19 was being discussed in the excerpt that was being
20 pulled out by Dr. Lauber? An inverted condition?

21 CHAIRMAN CARMODY: You want to identify which
22 excerpt so that we know.

23 BY CAPTAIN PITTS:

24 Q Well, there were so many, I'm not sure, but
25 we moved through one, and I thought he was using a

1 piece in the context of the training which spoke to an
2 aircraft that was, in fact, inverted.

3 A Was it the picture of the AAMP workbook?

4 Q No, it was just in the discussion leading up
5 to his questions.

6 CHAIRMAN CARMODY: Does the witness know what
7 we're referring to? Because it's hard for you to
8 answer if you don't.

9 THE WITNESS: I really don't.

10 BY CAPTAIN PITTS:

11 Q Okay, alright. Thank you very much.
12 Yesterday we heard from the aircraft manufacturer that
13 rudder use was appropriate to maintain coordinated
14 flight. Earlier, you spoke of pilot's ability to sense
15 through the seat of the pants, lateral accelerations
16 and how they might first make an instinctive move, and
17 then refer to the instruments for refinement. Would
18 you agree that in an upset recovery, making the correct
19 initial response is very important from the time to
20 respond perspective?

21 A I think in an upset condition that a quick
22 response is necessary to avert exaggerating that
23 condition.

24 Q Would you also agree that the simulator is a
25 procedural trainer to help us in training for making

1 those decisions?

2 A In reference to upset training, absolutely, I
3 think it is a very good and the best tool for
4 procedural training.

5 Q There was a reference to upsets made by Dr.
6 Lauber with transport category aircraft. Are you
7 familiar with an Air Force KC-135 example where a wake
8 vortices caused a violent enough roll to shed two
9 engines off of one wing?

10 A I am somewhat familiar with it. I have seen
11 some information about it, yes, sir.

12 Q And also possibly an Atlas Air 747 which was
13 in cruise flight lost over 15,000 feet over Canada?

14 A Yes, sir. I've read some information about
15 it.

16 Q As a training Captain, sir, is it your
17 expectation that the manufacturer's duty is to inform
18 operators of any flight maneuver or conditions that
19 would jeopardize the structural integrity of the
20 aircraft, and do that in the form of a prohibited
21 maneuver or limitation?

22 A As I mentioned earlier, when Captain Ivey was
23 questioning me, that I would expect, and do expect that
24 if a manufacturer has a structural concern, or a safety
25 concern, whether it be structural or not, with an

1 aircraft, that they would provide us, through formal
2 communication, whether it be by revision to the
3 operating manual or our bulletins, et cetera. Now,
4 there might be some communication other than that in
5 the form of phone calls, e-mails, to give us some
6 background information or give us a heads up that it
7 was coming, but certainly I would expect that would be
8 how they would communicate a concern to us.

9 Q Following the American Airlines 587 accident,
10 who first communicated to the pilots with these
11 concerns about lateral accelerations or alternating use
12 of the rudders in side slip?

13 A Can you restate your question, please?

14 Q Who first communicated with the pilots
15 regarding the concerns that were raised post-587?

16 A We did, as American Airlines, specifically
17 our technical group and myself -- I was included in
18 that, because of concern and information that we were
19 learning as a result of the accident investigation.

20 Q Do you consider the instructions in the
21 Airbus Flight Crew Operating Manual relating to landing
22 gear in normal conditions and the use of alternating
23 side slip to be conflicting with some of the concerns
24 that have been raised post-November 2001?

25 A I do, and that's why we have a pink bulletin

1 which takes precedence over a normal page in our
2 operating manual, the American Airlines operating
3 manual, and we have a specific bulletin that says to
4 not conduct alternating side slips, and I spoke to that
5 earlier about where we conduct 45 degree bank turns to
6 try to get the landing gear locked -- down and locked.

7 Q And in that case, the advocacy is to make
8 coordinated use of the rudders, is it not?

9 A To maintain coordinated flight, yes, sir.

10 Q And that's in confliction with the Airbus
11 FCOM, correct?

12 A As we read it, yes, as we understand what the
13 procedure is, yes.

14 Q Post-587 Airbus issued a recovery technique
15 from upset situations which endorsed a similar use of
16 rudder as in the industry training aid. Would you
17 agree with both the Airbus procedure and the industry
18 training aid which calls for use of careful or small,
19 or coordinated rudder as needed?

20 A I agree with that concept that if you run out
21 of your roll controls, and certainly if you're at high
22 angles of attack, that if you are continuing to roll,
23 unintentional roll, that you may need some small
24 amounts of rudder, yes, to avert that roll.

25 Q I'm going to refer to Exhibit 2-I, page five.

1 You want to bring that up, please? Recommendation
2 number two, if you'd like to highlight that, on the
3 right side of the page. If you'd let me know when you
4 have that, Captain Young.

5 A I have it in front of me.

6 Q Could you read to us recommendation number
7 two, sir?

8 A "Recommendation Number 2." -- and this is
9 from the Airbus Bulletin -- "Rudders should not be used
10 to induce roll or to counter roll induced by any type
11 of turbulence. Whatever the airborne flight condition
12 may be, aggressive, full or nearly full opposite rudder
13 inputs must not be applied. Such inputs can lead to
14 loads higher than the limit, or possibly to ultimate
15 loads and can result in structural damage or failure.
16 The rudder travel limiter system is not designed to
17 prevent structural damage or failure in the event of
18 such rudder system inputs." And there's a note:
19 "Rudder reversals must never be incorporated into
20 airline policy, including so-called aircraft defensive
21 maneuvers, to disable or incapacitate hijackers. As
22 far as a Dutch roll is concerned, yaw damper action and
23 natural aircraft damping are sufficient to adequately
24 dampen Dutch roll oscillations. The rudder should not
25 be used to complement the yaw damper. Note, even if both

1 yaw damper systems are lost, the rudders should not be
2 used to dampen the Dutch roll. Refer to the yaw damper
3 fault procedure."

4 Q Thank you, sir. And we received that in
5 March of 2002, is that correct?

6 A Yes, sir.

7 Q Had American Airlines ever received such
8 specific limitations or prohibited maneuvers on the
9 rudder use prior to the accident?

10 A No, sir.

11 CAPTAIN PITTS: I have no further questions.

12 CHAIRMAN CARMODY: Thank you, Captain Pitts.

13 Now to American. Mr. Ahearn, please.

14 MR. AHEARN: Thank you, Madam Chairman, and
15 because of the hour, I will attempt to be as brief as
16 possible. Most of my questions have already been
17 asked, but I do have a few.

18 CHAIRMAN CARMODY: Thank you.

19 QUESTIONING OF CAPTAIN YOUNG

20 BY MR. AHEARN:

21 Q Captain Young, in response to Dr. Lauber's
22 question on what First Officer Molin saw in AAMP, isn't
23 it true that First Officer Molin would have either seen
24 the course that was taped in your presentation, or one
25 virtually identical?

1 A Yes, sir.

2 Q Okay, moving on to simulators for a moment.
3 Do you believe that line pilots understand that the
4 simulator is incapable of recreating all the movements
5 and forces that you may feel in flight?

6 A I don't think there's any doubt of any pilot
7 in the world that when you walk into a simulator, this
8 is not going to exactly replicate an airplane 100
9 percent. And in particular, its limits are Gs or
10 lateral Gs or positive and negative Gs.

11 Q Okay, let me ask the same question with
12 regard -- do you believe the FAA, which approves our
13 training, has the same understanding?

14 A I think that the FAA has the understanding
15 that there are limitations with the simulator, but
16 we're also faced as an airline, and with the FAA is,
17 that you have to use the best tools that you have
18 available to train at the moment.

19 QUESTIONING OF MR. GHOSHAL

20 BY MR. AHEARN:

21 Q Question for Mr. Ghoshal. Mr. Ghoshal, based
22 upon the technical panel's questions that were offered
23 to you earlier, I want to clarify, in your presentation
24 that you highlighted that you can recover in the roll
25 exercise without the use of rudder. Isn't that, in

1 fact, not a true statement? You're not required to use
2 the rudder to recover from roll?

3 A It is.

4 Q I also want to clear up another issue that
5 there seemed to be some confusion from the technical
6 panel as well. There seems to be an impression that,
7 from statements that in order to return to the roll
8 control effectiveness, that it's always ten seconds.
9 Could you just clarify that and expand upon the ten
10 second phenomenon that was addressed earlier?

11 A Okay. The ten seconds phenomena was just a
12 time in case we did not reach the angle, but in most
13 cases, say for example it rolled right first ten
14 degrees and then it rolled left, say 110 degrees, total
15 of 120 degrees, approximately that would take four
16 seconds, and initially when it rolls to the right, the
17 pilot will try to control it opposing that, so by the
18 time he goes over, at 50 degrees of bank angle, we
19 start getting back both the yaw and roll controls back
20 in. So it is not ten seconds, it is from peak to peak,
21 it is maximum four seconds.

22 Q Thank you, Mr. Ghoshal.

23 FURTHER QUESTIONING OF CAPTAIN YOUNG

24 BY MR. AHEARN:

25 Q Just a few more questions for you, Captain

1 Young. Do you agree with Captain Rockliff that the
2 simulator preconditioned a rudder response to wake
3 turbulence?

4 A No, sir, I do not.

5 Q Can you tell me why not?

6 A As we talked that -- there's a lot of
7 correlation here, or there have been people that have
8 tried to correlate wake turbulence to our AAMP and
9 upset training. They are two very different, distinct,
10 differences with that. AAMP specifically was trying to
11 teach to upsets which the industry was concerned about
12 in 1995. Certainly we started trying to do something
13 about training upsets as an industry. Wake turbulence,
14 the only way that entered into the AAMP program was if
15 it resulted in a upset condition. As I mentioned
16 before, numerous times here, that no pilot out there
17 ever thought that every time you get into wake
18 turbulence you're going to end up in an upset. It just
19 doesn't happen. We experience wake turbulence all the
20 time.

21 Q Thank you, Captain Young. Just another point
22 of clarification. In response to the technical panel's
23 questioning, do you believe that it's up to the crew,
24 that the crew has the authority to call for max power
25 in an appropriate, or for that matter, any reason, and

1 it doesn't have to necessarily be associated with
2 escape maneuver?

3 A If they have concerns about power
4 requirements, certainly I would expect the pilots to
5 push the power up as long as they had shared those
6 concerns, or had those concerns about the aircraft
7 flying up to the firewall, or to the stops if you will,
8 on the throttles.

9 Q Two final questions for you sir. One, do you
10 agree with Captain Rockliff that AA flight 587 departed
11 from control flight before the vertical stabilizer
12 separated?

13 A I do not think it was in an upset. I do
14 think the crew, from everything that I've seen, looking
15 at the data, they were reacting to something, and
16 trying to keep the airplane coordinated and flying. So
17 I'm not exactly sure if an exact term of -- of -- did
18 you say out of control or -- I forgot the exact words.

19 Q Departure from control flight, sir.

20 A Departure from control flight. I never saw
21 anything that they had a departure from control flight
22 initially, or certainly not an upset.

23 Q And one final question, now that -- you
24 alluded to earlier that you had an opportunity to read
25 the CVR transcript, is there any indication that the

1 Captain disagreed with First Officer Molin's response
2 to the dynamic weight vortex that he was in?

3 A The CVR transcript that I received yesterday
4 morning did not indicate any disagreement at along
5 among the crew, between Captain States and First
6 Officer Molin, no.

7 MR. AHEARN: Okay, thank you very much,
8 Captain Young. Madam Chairman, if I might, there is an
9 Exhibit 2-I that refers to another FCOM that I believe
10 would be an appropriate part of the documentation.
11 We've had much discussion about that. It is -- refers
12 to the chapter procedures and techniques for upset
13 recovery that's referred to the document itself, so if
14 I might, I'd like to request that we add that to the
15 documentation and that as an exhibit.

16 CHAIRMAN CARMODY: What is the document
17 again? Would you repeat that? I didn't catch it.

18 MR. AHEARN: It's a document that is referred
19 to in Exhibit 2-I, and the specific document is a
20 procedures and techniques document, identified as
21 Flight Controls, and specifically it talks about
22 recovery techniques from upset training. It is a part
23 of the FCOM, or the flight crew operating manual from
24 Airbus.

25 CHAIRMAN CARMODY: Okay, I'd like to see a

1 copy of it, if you could make that available, then
2 we'll --

3 MR. AHEARN: I will, ma'am. Thank you very
4 much.

5 CHAIRMAN CARMODY: Sure. Thank you. Moving
6 now to my colleagues, Member Hammerschmidt. Questions.

7 MEMBER HAMMERSCHMIDT: Thank you. Just a
8 comment or two and perhaps a question. To begin with,
9 I just want to explore this first referenced issue for
10 these witnesses, the Advanced Maneuvering Program, as
11 we've been calling it, AAMP. And Dr. Lauber's
12 questions, I believe one of his first questions, he was
13 asking about something of the chronology of when some
14 changes were made to the role or the use of rudder in
15 this upset training. And I would just point out, if we
16 could put up Exhibit 2-delta, I believe, page 13.

17 I'm interested in the left hand side, the
18 aerodynamic definitions. I know last night I pointed
19 this out, but the handbook that we received when many
20 of us from the NTSB went to the training has a page --
21 this same page, page 16 in the workbook I guess we're
22 calling it -- and it's essentially the same as
23 referenced here except the only difference is where it
24 says the rudder -- on the slide we have before us,
25 where it says "the rudder becomes the most effective

1 roll control", the book that we have or that was given
2 to us says "the rudder becomes the primary roll
3 control."

4 And then the second paragraph here beginning
5 with the words "Smooth application" was not in the
6 October 1, '96 workbook. So I would just point that
7 out for clarification. In that three month span,
8 American Airlines made that change.

9 QUESTIONING OF CAPTAIN YOUNG

10 BY MEMBER HAMMERSCHMIDT:

11 Q As you mentioned, Captain Young, and I might
12 mention I certainly enjoyed your presentation this
13 morning --

14 A Thank you, sir.

15 Q -- that this workbook was meant to be helpful
16 material, it was not a stand alone training manual, I
17 believe you said.

18 A That is correct.

19 Q And it was meant as an aid in the actual
20 discussion which you showed many good video clips of
21 this morning. It was meant to supplement the
22 discussion.

23 A Yes, sir, and it was a booklet for people to
24 take notes and to supplement the discussion, yes, sir.

25 Q Well, I would like to go to the notes that I

1 took on that page, just very briefly, and I will read
2 them just exactly as I wrote them down. Concerning --
3 we could put that slide back up, please, 2-delta, page
4 13. And I just want to get your take on what I wrote
5 down.

6 A Yes, sir.

7 Q Okay. When we went to this particular page
8 in the instruction, down in the notes, I wrote, "For
9 example, coming in on approach, right wing drops down
10 due to wake, vortex, or whatever. Instinctively one
11 pulls back on yoke, dramatically increasing angle of
12 attack, therefore, roll control is achieved with
13 rudder, not ailerons, especially on MD-80." Is that a
14 fair depiction of what would have been taught at that
15 training session -- that ground school session?

16 A Right, I understand. I think that, and
17 specific in this case here, where you're close to the
18 ground, you're concerned about ground contact with an
19 uncommanded roll in this case, and there was some
20 discussion during that whole process about at
21 increasing angle of attack, which I would expect the --
22 for me, I think that anytime an aircraft rolls and it's
23 instinctive that a pilot will put in roll controls.
24 Since you're so close to the ground, you would possibly
25 pull back, increasing angle of attack. At that point

1 in time, the rudder would become an effective roll
2 control.

3 MEMBER HAMMERSCHMIDT: Okay, that's all I
4 have.

5 CHAIRMAN CARMODY: Thank you. Member Goglia.

6 QUESTIONING OF CAPTAIN YOUNG

7 BY MEMBER GOGLIA:

8 Q Just one point, Captain Young, that I would
9 like you to clarify since all of us use airline jargon
10 here, and there are a number of folks here that may not
11 be familiar with the terms that we use. You mentioned
12 early on in your presentation about crashing the
13 computer.

14 A Right.

15 Q And that's a term that we frequently use when
16 we exceed the parameters of the simulator.

17 A Right.

18 Q And usually the screen goes blank, and we
19 reset and start all over again.

20 A Right.

21 Q And I just want to make sure that that's what
22 you meant, for the benefit of those here who do not
23 understand the terminology that we use.

24 A Well, actually what I meant was -- displays
25 to the pilot will not go blank, but the motion will be

1 -- as a simulator, the cab of the simulator is elevated
2 on some hydraulic cylinders, and that's what gives you
3 these initial accelerations as you're flying around,
4 and inside the simulator it can give you the feeling
5 that you're somewhat flying. It tries to make it more
6 realistic. And what I was speaking to was that
7 sometimes if you exceed those parameters, it will
8 settle down off of those jacks and there will be no
9 motion at all of the simulator.

10 Q Thank you. I just wanted to make sure that
11 everybody understood what I think the rest of us
12 understood.

13 A Yes, sir.

14 MEMBER GOGLIA: No further questions.

15 CHAIRMAN CARMODY: It's important to clarify.

16 Thank you. Member Black.

17 MEMBER BLACK: Thank you, ma'am. Just a
18 couple questions.

19 QUESTIONING OF CAPTAIN YOUNG

20 BY MEMBER BLACK:

21 Q You showed some video clips in your excellent
22 PowerPoint presentation early on, and one of them was
23 Captain Vandenberg -- and I also, like John did, I had
24 this I believe -- this course at LaGuardia and I might
25 have even been in the class with one of the accident

1 pilots, by the way, and enjoyed the course. As a
2 matter of fact, one of the quotes in your presentation
3 might have actually been something I said. It looked
4 familiar to me. But I did enjoy the course and I
5 thought it had a lot of excellent qualities to it.

6 At time 9 minutes and 20 seconds into that
7 video, one of the clips you showed, that's what was
8 showing at the top, the Captain is talking about valid
9 -- he's talking about things he had observed -- and I
10 gather he was talking about observing them in the
11 simulator about the qualities -- this is when he talked
12 about "these big puppies don't respond the same as you
13 would expect a smaller airplane".

14 A Right.

15 Q Do you think he's talking about the simulator
16 or some other experience he might have had with a real
17 airplane?

18 A I don't think he took an actual large
19 transport category airplane and put it into 90 degrees
20 of bank. I think he was speaking of the simulator.

21 QUESTIONING OF MR. GHOSHAL

22 BY MEMBER BLACK:

23 Q Okay, well, that begs this question, and I
24 guess the next question would be to -- well, whoever
25 wants to answer it -- this alpha and beta envelope that

1 -- the code that's supplied by the manufacturer of the
2 aircraft or the manufacturer of the simulator, do you
3 get any sort of validation document when you receive
4 that? In other words, when you buy a simulator, do you
5 get something with some sort of assurance about the
6 validity of that simulator?

7 A Yes, sir, as a requirement for FAA
8 qualification, the simulators are checked against
9 flight test cases for like engine out take off, engine
10 out landing -- there are defined cases where you have
11 to actually match the flight test data within some
12 tolerance parameters. Is that what --

13 Q That's exactly what I mean, and I don't know
14 whether the staff would be interested. I might
15 actually. If you have a copy of that, or could produce
16 a document, I would like to see what that looks like,
17 if that's producible, or if it's not some sort of
18 proprietary document. If you can send me a copy, I
19 would appreciate it.

20 A Okay, sir. I'll look into it.

21 FURTHER QUESTIONING OF CAPTAIN YOUNG

22 BY MEMBER BLACK:

23 Q And another question about -- in the
24 interviews we had some of the transcripts here a minute
25 ago -- I read in preparation for this the transcript of

1 the interview with the OPS group, I believe Captain
2 Young was in on that, were you not?

3 A Yes, sir, I was.

4 Q Of the AMP, the Aircraft Program Manager for
5 FAA, I think the POI was interviewed also, and that's
6 probably a fairly new POI, is it not?

7 A Relative, it depends on what your definition
8 of new is.

9 Q Well, I think there was a change after
10 Little Rock, if I'm not mistaken.

11 A There was, yes, sir.

12 Q So he would not probably have been there in
13 '97, the current one would not have.

14 A No, sir, he was not.

15 Q Did they ever reference, or was there any
16 evidence of communication between the gentlemen who
17 signed the letter, as I call it, in capital letters,
18 from the manufacturers and the FAA -- was there ever
19 any evidence of the FAA group that signed the letter,
20 Captain Emmick I believe his name was, and the POI
21 about the concerns in that letter? Did you ever sense
22 that the POI or the AMP was concerned about anything
23 that was in that letter? This would be the letter from
24 the manufacturers and the FAA to Captain Ewell.

25 A No, in fact, the FAA -- they had looked at

1 our program and had approved our program, had been
2 through our exercises and simulator, and we had
3 dialogue with them before that, and they had never
4 expressed concerns about simulator fidelity, if that's
5 what you're speaking to, in relation to this. The FAA,
6 as I think we've heard before, that it was a desirable
7 training, and their HBATs, et cetera, and their
8 bulletins -- they wanted this training and we were
9 trying to put together the best program we could with
10 extracting information and expertise from the experts
11 out in the industry. So we didn't try to create this
12 in a vacuum.

13 Q Thank you, sir. I would also congratulate
14 you on your presentation. My personal opinion is
15 you're the kind of guy I would like to think about
16 teaching airline pilots. Thank you.

17 A Thank you, sir.

18 CHAIRMAN CARMODY: Thank you, Member Black.
19 I have no questions, this is the advantage of being
20 last. Everything's been covered. Are there any
21 additional questions, new questions, from any of the
22 parties, starting with Airbus, FAA, Allied Pilots, or
23 American? Thank you for your cooperation.

24 I would like to go ahead and start with the
25 next witness, if it runs too long, we will adjourn for

1 lunch, but I would like to get going with -- that would
2 be Captain Armand Jacob. So, Ms. Ward, if you'll call
3 the next witness, please.

4 And thank you, gentlemen, Captain Young, and
5 Mr. Ghoshal. Thank you for your testimony and your
6 time. You've been very helpful to our inquiry.

7 CAPTAIN YOUNG: Thank you, Madam Carmody.

8 MR. GHOSHAL: Thank you, ma'am.

9 (The witnesses were excused.)

10 MS. WARD: I call Captain Armand Jacob.
11 Whereupon,

12 CAPTAIN ARMAND HENRY JACOB
13 was called as a witness, and first having been duly
14 sworn, was examined and testified as follows:

15 BY MS. WARD:

16 Q Captain Jacob, could you please state your
17 full name, your current employer, and your business
18 address?

19 A My name is Armand Henry Jacob. I'm an
20 engineering test pilot, address, Flight Test
21 Department, and the address is Number 1 ... Beronte
22 (ph), B..., France. Q How long have you had
23 your position that you're in?

24 A I joined the test flight department in 1990.

25 Q And what are your current duties and

1 responsibilities, and the education and training that
2 you received to qualify you for your current position?

3 A Responsibilities consist in flying all
4 aircraft types in flight tests, development and
5 certification flight tests, also flying production
6 flights and any other flights; consist also in
7 providing expertise to the design office or new
8 development programs going on, or for modifications on
9 existing products. It also consists in participating
10 in the support department to operational conferences,
11 airline visits, and so on. I've logged about 7,500
12 flight hours, most of them in flight tests. I'm
13 holding a French test pilot's license, which is valid
14 for all transport type aircraft. I'm also holding a
15 French aircraft transport pilot license valid for all
16 Airbus types, with a German validation, and special
17 permit from FAA relative to all Airbus types.

18 I have been my whole career have consisted in
19 running in parallel pilot and engineering activities.
20 It started in 1970 when I got a Master's degree in
21 Aeronautics, and I joined the French Air Force Academy,
22 graduated as a test pilot -- as a fighter pilot, sorry,
23 the following year. Then I spent about 12 years in the
24 French Military Flight Test Center. Was involved in
25 many military programs, many testing, was also - and during

1 these years for a couple of years, I was teaching
2 aircraft performance and handling at the French Air
3 Force Academy.

4 I joined Aerospatiale in 1983 on the ATR-42-
5 72 program, and I was involved in the development and
6 certification of these two products. Eventually I
7 joined Airbus in 1990. I forgot to mention that I'm
8 also a graduate of United States Air Force Test Pilot
9 School.

10 Q Thank you, Captain Jacob.

11 MS. WARD: Madam Chairman, this witness is
12 now qualified and I'd like to pass it over to Dr.
13 Malcolm Brenner.

14 CHAIRMAN CARMODY: Yes, please go ahead.

15 BY DR. BRENNER:

16 Q Captain Jacob, a question came up yesterday,
17 can you fly the A300-600 without a stabilizer rudder?

18 A The answer, sir, is no.

19 Q Thank you. Yesterday also Mr. Chatrenet
20 indicated that in testing the airplane, he said test
21 pilots flew hundreds of maneuvers with the rudder in
22 normal service situations and in extreme conditions,
23 and said that many involved precise closed loop
24 response. Could you please describe the testing that
25 he was talking about?

1 A Yes, he was referring to the testing which is
2 done in development and certification, and this would
3 include typically, performing minimum control speed
4 tests, either on the ground or in the air. It would
5 involve side slip -- steady state side slips throughout
6 the envelope. It would involve engine failure
7 simulations or actual engine cutoffs in the whole
8 flight envelope. It would also include some maneuvers
9 not really dedicated to aircraft handling, but like
10 checking the response of the engine toward the envelope
11 for power transients and lack of stalling
12 characteristics, and obvious by doing this for obvious
13 safety reason, we would do it on one engine at a time,
14 and to stay precisely at zero side slip during this
15 kind of testing, it would require very precise inputs
16 on the rudder, and this is done throughout the flight
17 envelope.

18 Q The last one especially would be an example
19 of the "closed loop" that he was talking about?

20 A Of course.

21 Q Were there any adverse comments concerning
22 the rudder handling qualities during the testing?

23 A The rudder, as other flight controls, have
24 been thoroughly tested, not only by Airbus test pilots,
25 but also by test pilots from the French DGAC, test

1 pilots from ABA, test pilots from FAA, and have also
2 been evaluated by the flight standards people from
3 these authorities. In addition, the airplane type has
4 logged over 15 million flight hours, and this would
5 involve thousands and thousands of pilots, and from any
6 of this population of pilots, we have never got, to my
7 knowledge, any adverse comment about the
8 characteristics -- the design characteristics of the
9 rudder control system.

10 Q And what proportion of the testing would be
11 done at take off and landing speeds, and what
12 proportions, say, at 250 knots or above?

13 A Obviously, minimum control speed would be at
14 low speed. Concerning the side slip and engine
15 failures, this would be done throughout the flight
16 envelope, and of course at speeds at or close to 250
17 knots.

18 Q And Mr. Chatrenet was talking about the
19 reasons for designing these -- for changing to the
20 variable stop design, and indicated it was chosen
21 because it maintains control harmony between the wheel
22 and the rudder, as one of the considerations. What is
23 control harmony? Could you explain that?

24 A Yes, control harmony is a notion which is
25 related to a task. For a given task, it is the

1 relative displacement on forces on two different axes
2 of the flight control system, as related to a given
3 task. These forces and displacements, especially
4 forces, have -- it's recognized that there has to be
5 certain relationship of certain proportionality between
6 these two axes to have an acceptable or appropriate
7 control harmony.

8 Q If I understand, Mr. Chatrenet was indicating
9 that the forces between the wheel and the rudder were
10 in harmony.

11 A Yes, the effect, as air speed increases, on
12 any control surface, and this time I'm referring to the
13 surface that actually move in the air stream, the
14 effect of an increase of air speed on these surfaces is
15 proportional to the square of the speed. And as --
16 with the TLU system, like the one which is fitted on
17 the A300-600, this is a constant ratio. On the roll
18 axis, you also have a concentration system, so the
19 effect of going from one air speed to another affects
20 these two axes in the similar way, thus maintaining the
21 control harmony which was achieved at, say, low speed.

22 Q I guess my concern, if I understood Mr.
23 Chatrenet was referring to force harmony, but the other
24 aspect is displacement harmony, and my understanding is
25 the wheel has a constant range of travel throughout the

1 flight envelope, while in the variable stop design, the
2 pedals changes its range of travel at different air
3 speeds. Therefore, it seems that this design does not
4 maintain a harmony in terms of distance, and that this
5 would be very important to a pilot. Is that a fair
6 concern?

7 A No. Actually it does maintain harmony. Just
8 -- there is no limiter on the control wheel system, but
9 as an effect of air speed, affects it the same way than
10 on the rudder axis. Inputs made by pilots to achieve a
11 desired motion would be smaller and smaller as speed
12 increases.

13 Q But in terms of displacement, the speeds
14 involved in the accident, 250 knots we're discussing, I
15 understand the rudder pedal travels only about a third
16 of its full travel range. Is there a danger that a
17 line pilot might mistake the limited travel for a
18 jammed rudder or for some other problem and not
19 understand that this is the limit of the available
20 control?

21 A As mentioned by Captain Rockliff, a pilot
22 does not make arbitrary inputs to control his airplane.

23 A pilot flies his airplane in a closed loop situation,
24 which means that he is going to make the amount of
25 input which is required to achieve the desired motion

1 or objective he's looking for in his airplane.

2 Q I want to make sure -- what I'm thinking is
3 that to the pilot, the wheel still has the full play,
4 and yet the pedal does not, and this could be
5 confusing. I guess I didn't understand the answer, I'm
6 sorry.

7 A Okay, let me give an example. As Mr.
8 Chatrenet mentioned, the curve of the limiter has been
9 chosen to give enough authority to counter an engine
10 failure throughout the domain, depending on the air
11 speed. Thus, some room for yaw damper activity. And
12 this is what is needed, and a pilot would, under those
13 circumstances, either normal flight with an aircraft
14 without failure, or an engine out situation, never goes
15 to the stop. And therefore, of course, he would not
16 fear the stop and not be concerned about it being
17 there.

18 Q Thank you. And Mr. Chatrenet indicated, by
19 my notes, that in designing the --

20 CHAIRMAN CARMODY: Dr. Brenner, please speak
21 in your microphone, we're having trouble hearing you.

22 DR. BRENNER: Oh, I'm sorry.

23 CHAIRMAN CARMODY: Thank you.

24 BY DR. BRENNER:

25 Q Mr. Chatrenet indicated that in designing the

1 600 model, compared to earlier models, they lowered the
2 roll force by 30 percent from the earlier models for
3 more precise control of roll and lowered pedal forces
4 commensurate, to be consistent. Is this correct?

5 A This is correct in terms of forces, yes, sir.

6 Q And I notice that the witness before paid a
7 compliment to the airplane, the controls feel powerful
8 -- I think that may be related to the design
9 considerations.

10 A Yes, we actually got quite a few comments
11 from pilots from all over saying that they liked the
12 light and precise control of the aircraft.

13 Q But I think there could be a concern also.
14 In one area of the rudder use, the combination of the
15 very precise control with the variable stop design may
16 result in extremely sensitive handling qualities, and
17 this is particularly the air speeds involved in the
18 accident, takes 32 pounds of force to command full
19 rudder deflection, compared to 22 pounds of force
20 simply to make the pedal move. And my question, are
21 there test pilot guidelines on the ratio of maximum
22 force to break out force?

23 A Excuse me, just the end of your sentence, I
24 didn't get?

25 Q Are there test pilot guidelines -- here you

1 have a one and a half to one ration between moving the
2 pedal and getting maximum deflection in that area --
3 are there guidelines in terms of handling qualities as
4 to what one ideal ratio should be?

5 A The adequacy of flight controls for any
6 aircraft, when you go through testing and
7 certification, is evaluated with the airplane and the
8 pilot in the loop, which means that pilots are looking
9 for a given task or a given aircraft response, and if
10 this task is achievable without exceptional skill, and
11 if it's possible to achieve it in a precise manner, the
12 controls are satisfactory, adequate.

13 Q Is there a danger that a pilot might
14 inadvertently command full rudder when he intended only
15 to make a small rudder input, since he's not familiar
16 with this area and the relation between the two forces
17 is so close?

18 A This has been looked at, as I mentioned, by
19 many pilots -- the ability to make precise inputs has
20 been assessed and found satisfactory.

21 Q Have you experienced the pedal
22 characteristics, full input in the 250 knot range,
23 personally?

24 A Yes, I did by performing steady state side
25 slips.

1 Q Do you think that a pilot, using the pedal
2 for roll control, without training, would be able to
3 make precise inputs?

4 A We do not recommend to use rudder for roll
5 control.

6 Q It was a badly worded question, let me
7 rephrase. Do you think that pilots need training to
8 make precise entries in this air speed area, or is the
9 use so intuitive that a pilot could use it
10 appropriately without training?

11 A Again, it's basic airmanship to adjust inputs
12 to the desired aircraft response, and based on the
13 evaluation which has been conducted by test pilots from
14 various agencies, and these test pilots, it's their
15 basic -- it's part of their basic way of working, which
16 is to make sure that not only they can make precise
17 inputs, but the average airline pilot would be able to
18 do so, and by doing this they have found the controls
19 to be adequate and that an average pilot would be able
20 to make the required, precise inputs, depending on the
21 situation.

22 Q Then there might be a concern that as test
23 pilots, you're familiar with the design, and you're
24 working under precise situations, that a pilot who
25 might experience this in a dynamic situation, or an

1 emergency situation might have more difficulty. Is
2 this factor considered?

3 A This is taken into account when certification
4 authorities test pilots evaluate an airplane.

5 Q What are pilot-induced oscillations?

6 A Pilot-induced oscillation is a situation
7 where, in the closed loop situation, the pilot and the
8 aircraft response would get out of phase, resulting in
9 large, sustained oscillation with eventually the pilot
10 inputs and the aircraft response being in opposite
11 phase. Pilot-induced oscillation is characterized by a
12 very well measurable constant frequency of these
13 oscillations.

14 Q How did Airbus examine potential PIO issues
15 in the design certification of this system?

16 A Potential PIO issues -- all test pilots, when
17 they fly an airplane, have potential PIO tendencies or
18 issues in mind, so they are very -- any maneuver they
19 might do, if they sense or see any tendency to PIO,
20 they would notice it and they would be close -- a close
21 examination of the circumstances to determine whether
22 or not this was pilot-induced oscillation tendency.
23 Now, the absence of PIO tendency has been checked by
24 doing some demanding tasks throughout the flight
25 envelope, like engine failure with a delay of pilot

1 reaction up to three seconds, for example. And also
2 the very demanding task of conducting engine power
3 transients on one of the engines only.

4 Q Thank you. As part of its activities, the
5 Human Performance Group attempted to simulate the
6 motions of the airplane using the vertical motion
7 simulator at the NASA Ames Research Center, it's the
8 largest motion-based simulator in the world, and an
9 attempt was made using both CVR data and the FDR data
10 to try to recreate as close as we could, the
11 accelerations that the pilots would have felt, along
12 with the sounds in the cockpit. And you were a member
13 -- and I appreciate your observations -- of the VMS
14 trials.

15 In describing their observations, many human
16 factors group members described the first notable event
17 as typical of a crossing wake encounter. Was this your
18 impression? Do you know what I'm referring to?

19 A Yes, I concur to this.

20 Q Could you discuss that, please?

21 A Yes. As the other pilots in the group, I
22 have been faced with quite a few wake turbulence
23 encounters, and in a large airplane like the A300-600,
24 in all these encounters there was a essentially nil
25 reaction on the lateral axis, but there was a marked,

1 sharp kind of bump in the longitudinal -- in the
2 vertical axis I mean, sometimes in the longitudinal
3 one, and this was fairly consistent with what we
4 experienced in the VMS for the first encounter.

5 Q And then there was a second notable event
6 which then led directly into the accident situation.
7 And human factors group members observed that they did
8 not observe the visual or acceleration cue that would
9 lead a pilot to apply the observed initial magnitude of
10 wheel and pedal. Was this your impression?

11 A That was my impression too.

12 Q Can you describe, from a pilot background,
13 your impression of that area?

14 A Going through that simulator run, after the
15 first encounter, a couple of seconds later, there was a
16 little bit of unloading felt in the cockpit, which
17 means feeling a little bit lighter, but certainly not
18 any visual or force cue in the lateral that would have
19 led me, as a pilot, or any other pilot, that would
20 explain this very large -- this large and abrupt inputs
21 on the wheel and on the rudder pedals.

22 Q And based on the accelerations that you
23 experienced in the VMS, do you think the pilot's call
24 for max power was appropriate? Was it justified by the
25 acceleration?

1 A It was certainly not justified by the energy
2 situation in which the airplane was, because it was at
3 a fairly reasonable speed, in the middle of the flight
4 envelope, 250 knots. It was not close to the ground,
5 so certainly from an energy point of view, there was no
6 need for max power. In addition, the airplane was
7 already at climb power in the engines.

8 Q In one of the VMS trials, the inputs were
9 simulated -- the trial simulated the movement of a
10 rudder pedal system as would have occurred with a ratio
11 changer system, like that used on the earlier A300
12 models, and so we had the inputs displayed as they
13 would have moved the pedals on that. What was your
14 impression of this trial compared to the pilot's rudder
15 pedal inputs as displayed on the variable stop system
16 of the actual aircraft?

17 A May I just correct your sentence?

18 Q Please.

19 A You said that the inputs were made -- I mean
20 what is correct is that the rate of travel of the
21 rudder was kept as in the accident, and the pedals were
22 back driven as if the system would have been a variable
23 ratio system, which automatically makes these pedals
24 move three times faster than with the other definition.
25 And I do not think this is what would have happened

1 with the variable ratio system because in what we are
2 describing is just taking the problem backwards.

3 Q Yesterday, Mr. Chatrenet was talking about
4 cable elasticity analysis by Airbus. If I understood,
5 he indicated that during the accident sequence, these
6 part of these motions, the pilot input -- the pilot was
7 making inputs of 130 to 140 pounds, I believe was
8 estimated, which went beyond -- that he was pushing on
9 the rudder pedal beyond the force that would get to the
10 stop. Did I understand correctly?

11 A Yes, that's correct.

12 Q Could this be evidence that the pilot was
13 unaware of the design, and as he's straining to get
14 more rudder response because he's unaware that one-
15 third motion of the pedal is all that's available?

16 A Again, a pilot who's not flying his airplane
17 by numbers, deciding that he's going to put this much
18 rudder, is flying based on aircraft motion and desired
19 motion. So if a pilot is pushing on the stop, that
20 means at least that in his mind, he would like to get
21 more rudder input. Or more rudder deflection.

22 Q Thank you. Yesterday we heard testimony that
23 if the rudder inputs were made in a cyclic fashion at
24 or near the natural frequency of oscillation, only
25 small rudder inputs could produce very large amplitude

1 aircraft responses. I think analogy was made to a
2 child on a swing and being pushed lightly at the peak
3 points. How does the frequency of rudder inputs in the
4 flight 587 event compare to this natural oscillatory
5 frequency? Does this indicate that there might have
6 been an aircraft/pilot coupling, or pilot-induced
7 oscillation generated during this event?

8 A I don't think so. The only inputs that look
9 a little bit like constant frequency are the -- at the
10 very beginning of the large aileron and rudder inputs
11 going into the same direction, first right, then left,
12 and right again. And the frequency at which these
13 inputs are made is much higher than the natural Dutch
14 roll frequency of the aircraft at that speed.
15 Typically, the Dutch roll frequency, natural Dutch roll
16 frequency, would be -- I mean the period -- we talk
17 about the period -- the period would be, I would guess,
18 about five seconds. And these inputs were much faster.

19 DR. BRENNER: Thank you, Captain Jacob.
20 Captain Ivey will continue the questioning.

21 BY CAPTAIN IVEY:

22 Q Good afternoon, Captain Jacob.

23 A Good afternoon.

24 Q I'd like for you to describe the expected
25 inputs on the aileron/rudder system from the first time

1 a pilot enters the cockpit until he concludes his
2 flight.

3 A Okay. First of all, when a pilot enters the
4 cockpit, he's going to adjust his seat, adjust the
5 rudder pedals, goes through various items of a check
6 list, start engines, start to taxi, and some time
7 between the start of the taxi and being ready to line
8 up, there would be the flight control check, which
9 would consist in going from stop to stop on one axis
10 after the other -- pitch, roll and rudder, checking for
11 free play -- for free displacement, no anomaly on the
12 flight controls.

13 During the take off roll, the pilot would use
14 the rudder pedals to steer the aircraft. At low speed,
15 the efficiency of the rudder is obviously close to
16 zero, and that's why there is a linkage between the
17 rudder pedals and the nose wheel, this would allow the
18 pilot to keep the airplane straight on the runway
19 center line. Then at rotation -- then, of course,
20 during the -- as speed increases, the rudder becomes
21 more and more effective. This does not -- and the nose
22 wheel link -- I mean the relationship between ...
23 steering ... is decreasing, and therefore directional
24 control to stay on the runway center line would
25 primarily be insured by the rudder deflection.

1 Then -- I'm describing a flight without any
2 failures, that's what you wanted?

3 Q Yes, sir.

4 A Okay. So after rotation, gear would be
5 retracted, airplane would be flown and steered normally
6 using pitch and roll control, rudder pedal deflection
7 being essentially zero. The airplane would be cleaned
8 up, accelerated to climb speed, normal climb speed,
9 assuming the pilot would still hand fly it, of course
10 he would have his feet on the pedals as mentioned by
11 other pilots earlier, I concur to this, and prior to
12 engage the autopilot, once reaching climb speed, the
13 pilot would check the ball, the side slip indicator,
14 and if it is not centered, he would make a light -- the
15 required rudder input to center it and then trim the
16 force out, and then engaging autopilot for the major
17 part -- for the rest of the climb, the cruise and
18 probably the start of the descent. And, as mentioned
19 by other pilots, once autopilot is engaged, feet would
20 probably be resting on the floor -- there's no
21 requirement to keep feet on the pedal when not hand
22 flying.

23 I would expect a pilot, when he takes control
24 again from the autopilot prior to landing, to have his
25 hands on the yoke, and the feet on the pedal. And then

1 he would, after selecting flaps -- I forgot to mention
2 that in the cruise from time to time, probably be
3 required to make some small rudder trim adjustments due to
4 either slight asymmetry in fuel or any asymmetry of the
5 aircraft that would show up when changing speed. This
6 is quite common on this type of aircraft, that when you
7 go from one speed to another it requires a little bit
8 of rudder trim adjustment.

9 So going back now to approach, pilot --
10 assuming that approach would be manually flown, the
11 pilot would steer the aircraft down the proper
12 trajectory, either INS or visual, using pitch and roll
13 control. In the case where there would be cross wind,
14 the pilot, described by Mr. Chatrenet would go into a
15 crab to align the aircraft axis with the runway axis
16 while maintaining trajectory, with the roll control.

17 And then upon landing, after touch down of
18 the main wheel, the rudder would be used to steer the
19 aircraft down the runway. And then taxi back to the
20 apron and make the engine shut down checklist, and
21 eventually leave the cockpit.

22 Q So at any time during the normal flight, a
23 pilot would never expect to reach the limits of rudder
24 travel. Would that be a fair statement?

25 A That is a fair statement.

1 Q And in non-normal operations, such as an
2 engine failure at low air speeds, would a pilot
3 normally still expect to not reach the limits of a
4 rudder travel?

5 A Yes, he would normally expect not to reach
6 the limit because any operational speed is, by
7 regulation, above minimum control speed. He would
8 expect to reach the stop of the rudder pedal in case of
9 an engine failure at minimum control speed -- that's
10 the definition of minimum control speed. Operational
11 speeds having some margin in addition to this minimum
12 control speed, this would mean that a pilot under this
13 type of failure condition, i.e., an engine failure,
14 even at low speed, would not reach stop. This is also
15 true for higher air speeds.

16 Q Yes, sir. And I'd like to turn for a moment
17 to your experience as a test pilot, when you indeed
18 have to go beyond the normal operation limits that a
19 typical line pilot would experience -- let's use rudder
20 as an example. Do you reach the full stop limits in
21 design and certification on the A300 airplane with full
22 rudder displacement at some point during design and
23 testing?

24 A Of course we reach the full stop limit when
25 we do VMC minimum control speed testing, by definition,

1 again.

2 Q And that's at several points? That is at
3 different air speeds in the envelope?

4 A No, minimum control speed is -- there are
5 basically three minimum control speeds. One on the
6 ground, another one in takeoff configuration, and the
7 third one in approach and go around configuration. All
8 these minimum control speeds being defined by a sudden
9 engine failure and max power on the remaining one. So
10 we would definitely reach the stop in the case of
11 engine failures at these minimum control speed in
12 flight testing. We would also reach the stop in the
13 whole flight envelope for other type of exercises,
14 like, as I mentioned before, steady state side slips.

15 Q So you do at higher air speeds, and let's use
16 250 knots as an example, which would be an intermediate
17 air speed, are there times in design and certification
18 where you would indeed have full rudder pedal
19 displacement?

20 A Full available --

21 Q No, sir, just your application of full rudder
22 at say, 250 knots, is that part of your test program?

23 A Yes, in steady state side slips, for example,
24 yes, we go to the stop.

25 Q And what margin of protection is afforded

1 you, as a test pilot, before you start to engage in
2 that sort of activity? How much protection is allowed
3 you either through information or design, before you go
4 up there to fly that airplane and to place full rudder
5 travel in the airplane? Do you know how well you are
6 protected by the manufacturer?

7 A The rudder travel limiter is designed so as
8 to sustain -- so that the airplane can sustain full
9 sudden travel of the rudder at any air speed up to
10 VDMD. This is required by law. And we start first
11 flying an airplane, we are -- there are obviously some
12 -- a lot of temporal limitations before the whole
13 flight envelope is clear. And clearance of the flight
14 envelope implies many testing, like flutter testing,
15 like load measurements, to make sure that the airplane
16 is in accordance with the models that have been used to
17 design it.

18 Q And part of your design and certification
19 test plan is to test that rudder limiter system, is
20 that correct?

21 A Not really the system. The test plan
22 consists in making a whole set of exercises or
23 maneuvers in the whole flight envelope, and these
24 maneuvers are -- some of them are operational, some of
25 them are completely academic maneuvers. And steady

1 state side slip in the whole envelope are an example of
2 this academic maneuvers. And it is true that we go to
3 the stop in the whole flight envelope in this kind of
4 testing.

5 Q In earlier testimony, it was stated that
6 there was an envelope protection in the A300 -- no in
7 advanced fly by wire aircraft -- and to -- the rudder
8 system, that there is not that protection. Is that
9 correct?

10 A That's correct.

11 Q Why is the rudder system not protected within
12 its envelope?

13 A In a transport category airplane, there is no
14 circumstance that -- no normal procedure that -- or
15 actually, sorry, let me try it again.

16 Again, by definition, up to VDMD, whether on
17 A300-600 or an advanced airplane, the full motion of
18 the rudder up to the stop is possible without exceeding
19 design limit loads of the airplane. So the airplane --
20 all airplanes, by law, are protected against this type
21 of maneuvers -- one full stroke, all the way to the
22 stop.

23 Q You've flown both rudder limiter system
24 designs, is that correct?

25 A I have limited experience in the B2B4, but

1 yes, I have flown it.

2 Q And is the B2B4 the only Airbus airplane that
3 had the different rudder limiter design from the other
4 Airbus aircraft?

5 A All the 320 type aircraft, and the 330/340
6 type aircraft are all equipped with the limiting
7 system.

8 Q And I'd like to ask you, as a test pilot, and
9 as a general pilot, which system do you like the best?
10 Is there a difference that you've noted as a pilot?

11 A As a pilot, first of all, at low speed, when
12 I mean low speed is typically in the A300-600, speeds
13 below 165 knots, before the rudder limiting system
14 starts to move -- at low speeds, or where the rudder is
15 most likely to be used in engine failure case, or when
16 you really need the rudder, both systems are strictly
17 equivalent. So as speed increases, rudder, which has
18 been sized for the particular case of engine failure
19 take off at low speed, as speed increases rudder
20 becomes more and more effective as a function of the
21 square of the speed, and therefore less and less rudder
22 is required. And essentially, I think it was Captain
23 Delvin that mentioned it, in an airline very little
24 rudder is used or necessary as long as the aircraft has
25 no yaw or side slip asymmetry. So, as a pilot, I

1 really have no preference. Both systems are equal.

2 Q Talking about the variable ratio versus the
3 variable stop system, do you have a preference as
4 opposed to the pedal travel? Do you prefer to have
5 full pedal travel at all regimes of air speed, or would
6 you prefer the current system that's on the A300 where
7 you've got reduced pedal travel as the air speed
8 increases?

9 A I have reduced pedal travel, but again, in
10 any operational circumstances, I would not need to go
11 to that stop, and as I mentioned earlier, efficiency --
12 as -- with speed increases the same way as the
13 efficiency increases on the roll axis, so actually it
14 keeps a good harmony and I quite like the system. I do
15 not dislike the other one, but I have no preference.

16 Q Do you know why the new system was installed
17 on the advanced airplanes that was different from the
18 A300-B2B4?

19 A Say it again?

20 Q I'm sorry. Why was the system chosen for the
21 A300-600R? The rudder limitations?

22 A I think Mr. Chatrenet explained this pretty
23 well yesterday, and I concur to his explanation.

24 Q Alright. Is the variable limiter system a
25 unique design to Airbus airplanes?

1 A No.

2 Q Regarding the regulations, what's required
3 for rudder pedal forces and rudder limiting? Are there
4 any FARs that say how much that force has to be?

5 A There are definitely numbers or maximum
6 forces on all controls on all axes, and in the case of
7 the rudder, there is an indication that the rudder
8 forces should not exceed 150 pounds.

9 Q Is there any minimum requirement?

10 A There are no numbers for minimum
11 requirements. However, by checking and testing the
12 flight control system with all the certification
13 exercises that are required, these exercises would not
14 be satisfactory if the forces would be either too high
15 or too low. So this takes practically in to care of
16 the minimum forces required.

17 Q Do you think there ought to be a minimum
18 requirement for certain forces?

19 A I don't think so. I think the guidelines and
20 the way certification is conducted today takes care of
21 this, and it has been a sense of history to go for
22 lower and lower forces as technology improves.

23 Q Regarding the FCOM, is there written guidance
24 regarding any cautions about control input at speeds
25 less than DA?

1 A FCOM, no.

2 Q Is there any guidance at all that's been
3 added since the accident regarding speeds?

4 A Yes, as Captain Rockliff mentioned, in
5 response to the safety recommendations of NTSB, there
6 has been some additions put into the FCOM.

7 Q In the case of -- Boeing has, of course, been
8 the manufacturer for the KC-135, which was a variant of
9 the 707, perhaps back in the 1950's and early 60's. A
10 2K-3, for example has a caution in there, and it's been
11 part of the technical order Dash One, as it's called,
12 to the United States Air Force flight crews -- if you'd
13 like to put that up, 2K-3. I'll just read the caution
14 that has been incorporated in their manual for some
15 time, that "The sudden reversal of rudder direction at
16 high rudder deflections due to improper rudder
17 applications or abrupt release, can result in
18 overstressing the vertical fin. This condition could
19 be brought about during recovery attempts from a flight
20 condition induced by a lateral control malfunction."
21 Do you think that that's generic to the Boeing 707 or
22 KC-135 airplane, or do you think that's a good caution
23 for any large transport category airplane?

24 A I don't know which lateral control
25 malfunction this recommendation is referenced to.

1 Again, in all the published procedures, whether normal
2 or failure cases, there is no need for rudder
3 reversals.

4 Q And I certainly agree with you. I think that
5 that's what the caution is about, the fact that if they
6 were to start to have abrupt or cyclic rudder
7 applications that they're warning the crews about that
8 very issue. Do you believe that any cautions such as
9 that would have been useful in the FCOM, that might
10 have advised crews as to how to limit the use of
11 rudder, or an abnormal condition, or even in normal
12 operation?

13 A I don't think so. As I said, normal and
14 abnormal procedures do not require such inputs and if
15 in any very extraordinary and very remote situations --
16 I cannot imagine, but I think one could imagine such a
17 situation -- if you're really, for a reason I cannot
18 imagine, this type of input would be necessary, I do
19 not -- for preventing a drastic emergency situation,
20 being close to hit the ground -- I do not think that
21 this kind of limitations would have prevented the pilot
22 to do so if it would have been in the manual. Again, I
23 cannot imagine such a situation.

24 Q Has there been any time during your
25 experience as a test pilot, or during normal line

1 operations, you've ever had the need to use full
2 aileron or full rudder as a flight control input?

3 A In normal flight, no. In test flights, yes,
4 by definition of VMCA, there is not only a static
5 conditions to be satisfied, there is also maneuvering
6 conditions to be demonstrated, and again, at this very
7 low speed outside of the normal flight envelope, the
8 rudder is already on the stop because this is the
9 definition of the VMCA, you are required to demonstrate
10 maneuverability towards the live engine, and this, on
11 some airplanes, requires up to full aileron. So this
12 is a situations where you would apply full aileron and
13 rudder -- not apply full rudder -- the rudder would
14 already be on the stop before starting the maneuver.

15 Q I would like to ask you also what your
16 definition of coordinated rudder means.

17 A I agree with the definition given by the
18 other pilots. Coordinated rudder means ball or side
19 slip indicators center.

20 Q Has Airbus ever provided you, either in the
21 A300 airplane, or in any other airplane or simulator,
22 upset maneuver training?

23 A No, upset maneuver is kind of -- maneuver
24 recovery is kind of basic airmanship for test pilots.

25 Q And I'd like to ask you, have you performed

1 any flight tests regarding the roll and yaw of the
2 airplane as it pertains to the accident flight?

3 A The answer is no.

4 Q As a test pilot, what are your concerns about
5 using simulators for training upset maneuvers, wake
6 turbulence encounters?

7 A I concur with what has been said by Captain
8 Rockliff yesterday, Airbus does not advocate use of
9 simulators for such training because of the risk of
10 negative training.

11 Q What changes have been incorporated or are
12 being considered relative to the Airbus flight control
13 system as a result of this accident?

14 A No changes considered.

15 Q And are there any changes anticipated in
16 flight crew guidance, warnings, or cautions? Is there
17 any other considerations as a result of this accident
18 by Airbus?

19 A Nothing in addition to what has already been
20 provided per NTSB recommendations.

21 CAPTAIN IVEY: Thank you, Captain Jacob, that
22 concludes my questions.

23 CHAIRMAN CARMODY: Thank you, Captain Ivey.
24 Are there other questions from the technical panel?
25 Yes, Mr. Clark.

1 BY MR. CLARK:

2 Q I heard the discussion earlier about harmony,
3 and the sense I got was that harmony is important for
4 precision flying. Is that correct?

5 A That's correct.

6 Q How important is it in the event of some sort
7 of upset recovery?

8 A Upset recovery does not require inputs on --
9 simultaneous inputs on roll and yaw, therefore control
10 harmony would not be an issue.

11 Q Then, it's -- and correct me if I'm wrong.
12 I'm going to give my impression here real quick and
13 then ask your opinion. It seems we put a lot of work
14 into building control loading -- those kind of issues
15 in the pitch mode, but it seems that kind of detail is
16 not put into the lateral mode, or the yaw mode. Is
17 that correct?

18 A Lateral -- roll control, certainly there's --

19 Q I mean yaw mode.

20 A Yaw mode -- I have to go back to what the
21 rudder is designed for on a transport category
22 airplane. A rudder is there to steer the airplane
23 during takeoff and landing roll, to de-crab in case of
24 a crosswind landing, and to zero out any thrust or yaw
25 asymmetry that might occur. And the amount of testing

1 that is put in is in accordance with these design rules

2 Q In the pitch mode, we put in parameters to
3 make the forces get greater at higher speeds to make it
4 more difficult for the pilot to overcontrol the
5 airplane. Why is that not also applied in the rudder
6 mode?

7 A In the pitch mode there are, on this kind of
8 large airplane, mechanical controls. These kinds of
9 devices are necessary because the pitch axis is
10 affected not only by air speed, but also by magnum (ph)
11 effect, center of gravity effect, and angle of attack
12 effect. So it's a much more complex situation, and
13 this is why it requires this kind of devices to take
14 care of that.

15 Q Okay, and I guess the inference is then,
16 those kinds of issues don't exist in the directional
17 mode?

18 A Directional mode and roll mode are affected
19 only by air speed effect, which is pretty predictable
20 and which pilots are used to in everyday flying. They
21 know from day one, from their initial training and
22 their theoretical background, that the effect of the
23 controls is -- depends on the square of the speed.

24 MR. CLARK: Thank you.

25 CHAIRMAN CARMODY: Alright, I'd like to go

1 ahead and start with the parties, and I think the order
2 this time, we'll start with American, then Allied
3 Pilots, then the FAA and finishing with Airbus with
4 this witness. So Mr. Ahearn, do you have any questions
5 for this witness?

6 MR. AHEARN: I do, ma'am, and I'll try to --
7 again, for the sake of time, as brief as I possibly
8 can.

9 BY MR. AHEARN:

10 Q Good afternoon, Captain Jacob.

11 A Good afternoon.

12 Q Let me start off by talking about this issue
13 of control harmony, because I want to make sure I
14 understand what you had stated earlier. You stated
15 that control harmony exists in all flight regimes, and
16 I'm having a little bit of hard time understanding
17 that. With the speed increasing from 165 knots to 250
18 knots, the traveller limiter reduces the pedal distance
19 from four inches to 1.3 inches, and it changes the
20 break out force -- I'm sorry -- the pedal force after
21 break out from 45 pounds to 10 pounds, and there's no
22 corresponding change in roll. I'm trying to understand
23 how that can be control -- or how you can have control
24 harmony with that type of system.

25 A Control harmony, as I mentioned earlier, has

1 to be associated to a task. Typically, when you de-
2 crab your aircraft for landing, this is a pilot task,
3 and it's important to relate the control harmony to the
4 task. The amount of rudder which is required, the
5 amount of aileron which is required under these forces
6 are in harmony. At high speed operationing, control
7 harmony is assessed by performing steady state side
8 slip up to the maximum available rudder deflection.
9 And control harmony is maintained because, as I
10 mentioned earlier, the effect of air speed on both axes
11 is the same. When the rudder reaches the stop, the
12 exercise is at the end, and control harmony makes no
13 sense any more above the -- after deflection which does
14 not exist.

15 Q So from a pilot's perspective, though, the
16 reaction that he would be receiving, and again, not
17 using the rudders at the speeds of 250 knots with a
18 high degree of frequency, the average pilot wouldn't
19 use it very often as testified earlier, would he not
20 potentially be surprised by the deflection that you
21 would get at 250 knots with only 1.3 inches of travel
22 and ten pounds of force after break out?

23 A Pilot is not flying by numbers, as mentioned
24 several times earlier. Pilot is flying by checking the
25 response of the aircraft to his inputs and continuously

1 adjusting his inputs. That is what is called closed
2 loop to achieve the desired response.

3 Q Would the sensitivity of these rudder pedals
4 -- how can a pilot use less than maximum rudder,
5 especially when he's in a dynamic turbulent event?

6 A What do you mean by a dynamic turbulent
7 event?

8 Q Well, there appears from what we've seen,
9 quite a bit of movement of this aircraft and in doing
10 so -- let me back up to a -- previous events. Earlier
11 yesterday, there was quite a bit of commentary about
12 the coordination amongst the flight department and the
13 engineering team and we referenced two in service
14 events. Are you familiar with the in service events of
15 the A310 in 1991, as well as the event of American
16 Airlines Flight 903?

17 A I wasn't directly involved, but I have the
18 general information about this, yes.

19 Q In both of those cases, these pilots were in
20 somewhat of an excited state, and it appears in both of
21 these cases the pilots used maximum deflection,
22 resulting in rudder doublets, resulting in some obvious
23 exceedence of load limitations on the vertical
24 stabilizer. That's what I mean by -- when I asked the
25 question of dynamic event. How can, when a pilot is in

1 a dynamic event as the pilot was in 1991, as well as
2 the pilot in 1997, how can he possibly get to less than
3 full stop with only ten pounds of force to get him to
4 full stop?

5 A These two events you are referring to are
6 characterized by a common factor. Both events were
7 loss of controls -- temporary loss of controls -- and
8 were not identified as such, and the inputs which were
9 made that were kind of open loop inputs, which do not
10 really correlate with observed -- or any motion that
11 was observed during these events. To address these two
12 events, we addressed the root cause of both of them,
13 which is to reduce the probability to enter these
14 events in the future.

15 Q Okay, let me move to another question. You
16 said earlier that you had no preference between the VLA
17 or the RTL system, because you had never used full
18 throw. Wouldn't it be easier for a pilot to modulate
19 controls to some point below maximum with four inches
20 and 45 pounds of travel, compared to 1.3 inches and ten
21 pounds of travel? And I know you addressed the issue
22 that they're not -- pilots don't move the pedals to
23 poundage, but visualize the fact that you have an
24 opportunity to, after break out, in a VLA type system,
25 you have, throughout the flight envelope, a full four

1 inches of travel, where in the RTL system, you go from
2 four inches to 1.3 at the 250 knots -- something less
3 than that. Would it not be significantly easier for a
4 pilot to modulate the pedal throws when you have the
5 full four inches throughout the flight envelope?

6 A I don't think so. The rudder system behaves
7 exactly like the roll systems, so pilots are used to
8 adapt their entries as speed increases. Coming back to
9 the 1.3 inches, actually this means two times 1.3
10 inches because as one pedal is moving forward, the
11 other one is moving back. This is a quite significant
12 motion for this control system.

13 Q And likewise, from that point then, if it's
14 1.3 equalling 2.6, then in the VLA, you would have
15 eight inches in total, versus four.

16 A That is correct.

17 Q Okay. I just want to make sure that we have
18 all the understanding associated with the transition
19 from the VLA to the RTL system, from the B2B4 to the
20 300-600, and again, I just want to ask you to describe
21 the -- how you evaluated the handling qualities as you
22 transitioned from the VLA to the RTL.

23 A For any new aircraft certification, or any
24 new aircraft type, you have to go through a whole set
25 of certification exercises and tests. And the

1 regulation is not specific to any type of design. So
2 every aircraft design is evaluated on its own. Does
3 that answer your question?

4 Q Well, let me get a little more specific.
5 When you were testing the 300-600, what cautions,
6 restrictions or limitations were the flight test pilots
7 aware of concerning how and when to use the rudder, or
8 how it should be applied? What types of cautions did
9 you offer to the test pilot?

10 A There are the usual cautions that are
11 associated with any test flight. When you are flying a
12 development aircraft, there are pages of temporary
13 limitations and some others related to the type of
14 exercise you are going to perform. So could you
15 precise which exercise or which type of flight you are
16 referring to? In general, there are no specific
17 limitations.

18 Q I'm referring specifically -- limitations to
19 the use of rudder.

20 A Depending on what the flight was about, when
21 you are doing a Dutch roll testing, obviously at
22 Airbus, we -- there are different ways to excite a
23 Dutch roll, and one of the ways to excite a Dutch roll,
24 as taught in test pilot school for military type of
25 aircraft, is rudder doublets. Are you referring to

1 that?

2 Q Yes.

3 A So when we go for flight where we are going
4 to perform Dutch rolls, it's part of the briefing to --
5 between the flight test engineer that has written the
6 flight test order, and the rest of the crew, to cover
7 this issue, and remind that the standard procedure at
8 Airbus flight test to launch a Dutch roll is to arise
9 from a steady side slip, not doublets.

10 Q So the restriction for the test pilot would
11 have been that it would have been from a steady side
12 slip, you would not allow the test pilot to do
13 doublets.

14 A That's not a -- in -- doublets -- no, it's
15 not a standard procedure at Airbus to generate Dutch
16 roll while performing doublets.

17 Q Throughout any type of flight testing that
18 you did on the 300-600, were there any restrictions on
19 the flight test team about conducting what are
20 doublets, whether it is associated with Dutch roll or
21 any other maneuver?

22 A We use very small -- we use small and careful
23 doublets from some of the analytic tests we perform for
24 simulator that are -- but then -- rudder doublets, by
25 themselves do not overstress an aircraft if they are

1 not at the right frequency, corresponding to the
2 natural Dutch roll. You can make Dutch roll test with
3 rudder doublets, provided it is properly performed.

4 Q And do you do that with -- I presume you do
5 that with the engineers monitoring it on the ground, so
6 you're being advised by the engineers on the ground
7 when to deflect the rudder in one way or another?

8 A No.

9 Q So that's done in flight. Okay. Is that
10 done at all speeds throughout the flight envelope?

11 A Dutch roll tests?

12 Q Yes.

13 A At all speeds and preferably releasing from
14 steady state side slips.

15 Q Okay, thank you. Just come back to one
16 question, and then I have one final question after
17 that. I believe you stated this earlier, and I want to
18 make sure I understand it, that you conducted steady
19 heading side slips throughout all portions of the
20 flight envelope on the 300-600. Is that true?

21 A The flight test team at that time, and I was
22 a part of it, yes, we conducted steady state side slips
23 throughout the flight test envelope.

24 Q And in doing so, do you know if the test
25 pilots were able to achieve stabilized interim rudder

1 pedal position at speeds of 250 knots or above?

2 A The answer is yes.

3 Q Do you know if that data has been shared with
4 the human performance team yet? The data points --

5 A I don't know. This data is certainly
6 available at the flight test -- at the certifications
7 authorities. It has been shown to them.

8 Q Okay, thank you. Let me just move on to one
9 final question. You said nothing in the VMS loads
10 explain the pilot's reaction. Were the VMS
11 accelerations accurate?

12 A In the dynamic phase of the VMS, yes, they
13 were pretty accurate.

14 Q Do you believe that they possibly could have
15 been reduced -- that the accelerations could have been
16 reduced due to sampling rate?

17 A I don't think so because the sampling rate is
18 quite -- quite adequate for the acceleration
19 parameters. They might be missing some high frequency
20 accelerations like vibrations, yes, but -- certainly.
21 But the general overall accelerations are certainly
22 very well represented in that VMS.

23 Q Okay, so then, just one final question on
24 that issue, then. Do sampling rates and the conditions
25 associated with the wake vortex -- couldn't the

1 pilots have seen much higher loads than what is being
2 presented in the VMS?

3 A I don't think so.

4 MR. AHEARN: Okay, thank you, Madam Chairman.

5 CHAIRMAN CARMODY: Thank you, Mr. Ahearn.

6 Moving on to Allied Pilots, Captain Pitts, please.

7 CAPTAIN PITTS: Thank you, ma'am.

8 BY CAPTAIN PITTS:

9 Q Good afternoon, sir.

10 A Good afternoon.

11 Q Regarding the VMS, was the equipment at the
12 VMS fully capable of representing the flight parameters
13 as recorded on the FDR, or did they have to be adjusted
14 to protect the equipment at the VMS?

15 A What do you mean the flight parameters?

16 Q The recorded flight parameters on the FDR --
17 was the VMS able to accurately replay those without
18 some adjustment, or was it forced into a reset mode
19 when those were replayed?

20 A It was -- all the runs that I was on board
21 were no reset mode, but I know that there has been some
22 occasions has been a reset of the VMS.

23 Q Was there a discussion that you recall about
24 the VMS not being able to accurately represent the
25 recorded flight parameters?

1 A No, to my knowledge, the VMS was adequate to
2 represent the flight parameters.

3 Q Yesterday, sir, Mr. Chatrenet testified that
4 Airbus did not use the Cooper-Harper rating scale in
5 its flight test program as an evaluation tool, and
6 we've had many discussions on that. What is the
7 quantifiable method that's used by the test pilot in
8 lieu of that program?

9 A Cooper-Harper is a rating scale which, to my
10 knowledge, is pretty well adapted to military type
11 aircraft. It's not really used in the industry for
12 transport category airplane. We rely mainly, at
13 Airbus, and I guess it is the same at other
14 manufacturers, on pilot appreciation of the quality of
15 the result, and actually at each test flight, there is
16 a debriefing with the design office that lasts for,
17 sometimes several hours, that allows to provide them
18 with feedback which is much richer than just the
19 Cooper-Harper rating. We go to great details, when we
20 discuss the results of any flight test.

21 Q Would you call that a quantifiable program or
22 a qualifiable program, or subjective evaluations?

23 A It's an evaluation of the overall behavior of
24 the aircraft, and as I mentioned before, this is how
25 the certification test pilots work as well -- they

1 check that if the aircraft meets the certification
2 requirements that they have in mind at each stage of
3 this work, the fact that the airplane will be flown by
4 an average airline pilot, and they have this in mind
5 when they check the adequacy of the aircraft to the
6 pilot.

7 Q So then would that be subjective?

8 A It's an objective evaluation. Not a
9 subjective one, it relies on the very well defined
10 tests and checked against rules which are quite
11 precise.

12 Q So when checking it against the rules that
13 are precise, if I understood you correctly, then you're
14 qualifying it to known uniform parameters in
15 man/machine interface?

16 A We qualify it to -- we check it -- we -- and
17 that means test pilots from manufacturers and from the
18 certification authorities -- qualify the suitability of
19 the aircraft. And it's described in the regulation and
20 then there are -- there is a general statement in the
21 regulation -- would you like me to read it for you? It
22 says "It must be possible" -- and it's about airplane
23 handling -- "The airplane must be safely controllable
24 and maneuverable during takeoff, climb, level flight,
25 descent and landing." And it states -- it's 25.143 (b)

1 of the Part 25 rules, "It must be possible to make a
2 smooth transition from one flight condition to any
3 other flight condition without exceptional piloting
4 skill, alertness or strength, and without danger of
5 exceeding the airplane limit load factor under any
6 probable operating conditions, including certain
7 failure of the critical engine, configuration changes"
8 and so on. So when the evaluation is conducted, it is
9 in relationship to this kind of rules, and this is an
10 example of the rules which are used by certification
11 authorities pilots.

12 Q So the evaluation is measured against a
13 regulatory compliance.

14 A Against a regulatory compliance which covers
15 the capability or the adequacy of the airplane to be
16 used by an average line pilot, and it's also covered --
17 it's also checked against a lot of maneuvers which are
18 not operational, but which allow to get access to
19 certain derivatives which will allow authorities to
20 check the adequacy of the handling of the airplane.

21 Q Alright, sir. In your opinion as a test
22 pilot, sir, can artificial trim and feel (ph) system
23 which has small displacements and light force gradients
24 lead to a severe over-control, especially in the
25 dynamic environment of turbulence or an upset?

1 A I don't think so. Any flight control, any
2 control system, if you make an arbitrary foot stroke
3 open loop input, will certainly need to initial over-
4 control.

5 Q I'm not sure I understood your answer there.

6 A Sorry, I will phrase it another way. Could
7 you ask your question again?

8 Q Yes, sir, I'll be glad to. Can an artificial
9 trim and feel (ph) system which has small displacement
10 and light force gradients lead to severe over control,
11 especially in a dynamic environment of turbulence or
12 upset?

13 A If used as it has been designed for, the
14 answer is no. Use has been checked in turbulent
15 conditions and in high pilot abandoning task
16 conditions.

17 Q So when you mentioned used as it was intended
18 and checked for, would the human then be subjected to
19 this kind of test of turbulence, to see if they could,
20 in fact, perform precise maneuvers?

21 A The airplane has been flown in turbulence, in
22 high turbulence, especially during icing (ph) trials,
23 and the adequacy of the roll flight control system has
24 been assessed in this kind of conditions.

25 Q You mentioned icing (ph) trials, was the

1 aircraft flown in the presence of wake vortex for the
2 same sort of testing?

3 A For testing, no. There's no deliberate
4 research to fly into wake vortices throughout the
5 flight testing.

6 Q Alright, sir, thank you. You mentioned basic
7 airmanship earlier, a couple of references. What
8 guidance does Airbus provide for you in terms of upset
9 or unusual attitudes? Is there a company policy in how
10 you would handle the aircraft?

11 A When you mean you -- you mean for the test
12 pilots of the company?

13 Q Sure, yes.

14 A No, test pilots have extensive engineering
15 background and they are very familiar with the
16 aerodynamic principles that lead to an upset or to
17 apply in an upset like full stalls or whatever, or even
18 a spin, and this has been -- this knowledge has been
19 acquired throughout their background, starting in, for
20 most of the test pilots have flown fighters, and they
21 have been through test pilot schools, and -- at Evers,
22 for example, when we do flight tests which are likely,
23 in the early stage of the program, there are many, many
24 occasions where likely you would end up in an upset,
25 and when this kind of tests are scheduled, it is always

1 a senior test pilot in one of the seats, and we take
2 advantage of this kind of test to have a less senior,
3 junior test pilot in the other seat, to get him in
4 situation, awareness and training. This is how this
5 knowledge is acquired. It's gained by, based on a
6 thorough theoretical knowledge of this kinds of
7 situations.

8 Q So you're saying in lieu of a written
9 guidance, you use experienced, more experienced test
10 pilot to ensure that the prohibited maneuver or
11 limitation was not exceeded.

12 A No, we use experienced test pilots when very
13 demanding tasks where loss of control might be
14 experienced, like early stalls at full aft CG in the
15 program, and then we used the definitely experienced
16 test pilots to do this kind of test. Just basically
17 how it works.

18 Q In those tests, you referenced doublets. How
19 is the difference between a doublet and an alternating
20 side slip addressed in those flights you mentioned?

21 A Side slip is a stable situation. When I'm
22 asked to put an aircraft into a side slip, I will put
23 it into a side slip and limited to a side slip. This
24 is just -- a side slip is a stable situation. A
25 doublet is not. A doublet a dynamic entry on the

1 flight controls.

2 Q Is an alternating side slip a dynamic or a
3 steady situation?

4 A No, an alternating side slip is a succession
5 of two steady situations.

6 Q So I'm confused. What's the difference
7 between that and a doublet?

8 A A doublet would be -- a side slip is a
9 precise maneuver, steady state side slip where you
10 exercise, you put progressive input on the rudder and
11 you -- accordingly, you make an input on the roll
12 controls to keep your trajectory straight. This is a
13 side slip. A doublet is just -- I'm going open loop
14 now -- a doublet is typically an open loop input which
15 consists in deflecting a given amount of rudder for a
16 given time, and then the opposite amount of rudder for
17 the same given time. It's a test maneuver which is
18 taught in test pilot school, and which is used on
19 military type aircraft.

20 Q Okay, back to that alternating side slip.
21 You mentioned a limitation, I believe. There's a known
22 limitation how far you would take that, is that
23 correct?

24 A No. Side slips?

25 Q Yes, sir, alternating side slips.

1 A Alternating side slips is the side slip
2 necessary to lower the gear or at these speeds you can
3 go to side slips up to the rudder stop.

4 Q But back to your comparison --

5 A Yes, the rudder stop.

6 Q Back to your comparison of the alternating
7 side slip versus a doublet, it sounded as if there was
8 a limitation that you placed on the more precise
9 maneuver. I think you referenced in the side slip --
10 alternating side slip.

11 A In the side slip there is no -- what kind of
12 limitations?

13 Q Well, maybe I need to go back --

14 A Please.

15 Q -- and clarify for me. I think the confusion
16 I had was what's the difference between an alternating
17 side slip and a doublet?

18 A As I mentioned, the side slip is a steady
19 situation. When I go into a side slip, I apply
20 progressively, rudder, apply roll control to keep my
21 airplane flying a given heading or trajectory, and I
22 leave it there for steady condition. And once this
23 steady condition is established, I am in a steady side
24 slip. This is a steady situation.

25 Q So then in order for me to execute an

1 alternating side slip and avoid the hazard of a
2 doublet, do I need to put that aileron control in?

3 A If you want to keep your trajectory straight,
4 that's the reason why you would put your aileron
5 control in. If you apply rudders to generate the side
6 slip and you put no aileron control in, you are going
7 to generate roll that way, as mentioned many times
8 during the various testimonies. It is not the intent.

9 Q That would be an adverse condition to execute
10 alternating side slip without aileron input?

11 A That would just not be a side slip, steady
12 side slip. It would be something else.

13 Q But sir, I'm not asking you about steady side
14 slip, I'm asking about an alternating side slip.

15 A Alternating side slip is a succession of two
16 side slips. A side slip, by definition, is something
17 which is steady, not dynamic.

18 Q Okay. Sir, do you know a gentleman by the
19 name of -- and forgive me if I mispronounce his name --
20 Gerard Guiot? G-U-I-O-T?

21 A Yes, I do.

22 Q And do you know his position at Airbus?

23 A He is retired.

24 Q Formerly?

25 A Formerly he was the chief of the flight test

1 engineers.

2 Q The most experienced flight test engineer?

3 A He was an experienced flight test engineer,
4 yes.

5 Q Are you aware of the work he performed in
6 conjunction with the loss of control, joint safety
7 analysis team, conducted by the Commercial Aviation
8 Safety Team?

9 A I'm not aware.

10 Q Alright, sir. And I don't mean to spring
11 that on you, but in their work in 2002, an opinion of
12 simulator training and its appropriateness for use in
13 advanced maneuvering training was achieved, and Mr.
14 Guiot was a part of that. Would his evaluation of the
15 simulator for use as an advanced maneuvering training
16 device be in conflict with Airbus policy?

17 A Airbus policy is not to advocate use of
18 simulator for large upset training. Some of the
19 maneuvers in -- contained in AAMP might fit quite well
20 in simulator, some don't.

21 CHAIRMAN CARMODY: Captain Pitts, may I ask
22 you how much longer you expect to be with our
23 questioning?

24 CAPTAIN PITTS: I have approximately six to
25 eight more question, I'm not sure how long it'll take.

1 The answers are very long.

2 CHAIRMAN CARMODY: Okay, well, maybe the
3 questions need to be reduced somewhat. I think we're
4 going a little bit in circles, but I appreciate your
5 cooperation. I hope to finish with this gentleman in
6 time for us to take a lunch break soon.

7 CAPTAIN PITTS: Yes, ma'am, I'll endeavor not
8 to go in circles.

9 CHAIRMAN CARMODY: Well, I think we have
10 been. Thank you.

11 BY CAPTAIN PITTS:

12 Q Sir, are you familiar with the term aircraft/
13 pilot coupling?

14 A Yes.

15 Q I'm going to reference Exhibit 14-C, page 3,
16 if you will bring that up, please. While they're doing
17 that, could you explain to me your understanding of the
18 difference between pilot-induced oscillation and pilot-
19 involved oscillation?

20 A Sorry, can you --

21 Q Yes, sir. Could you explain for me your
22 understanding of the difference between pilot-induced
23 oscillation and pilot-involved oscillation?

24 A I know pilot-induced oscillations, I am not
25 familiar with pilot -- again?

1 Q Pilot-involved oscillation.

2 A -- involved oscillation. No.

3 Q Would pilot-induced oscillation imply that it
4 is the pilot, singular, that might be causing the
5 oscillation?

6 A In the pilot-induced oscillation, it's
7 actually -- it's a closed loop situation where --
8 involving the pilot and the vehicle -- airplane in this
9 case -- into a situation where the inputs of the pilot
10 would eventually, coupled with the aircraft response,
11 end up in a situation where the only way to stop --
12 practically to stop this cycle would be to release
13 controls. That's pilot-induced oscillation.

14 Q I'm going to ask you to read the first two
15 paragraphs for us, please, sir.

16 CHAIRMAN CARMODY: Is it necessary to read
17 the first two paragraphs?

18 CAPTAIN PITTS: Madam Chairman --

19 CHAIRMAN CARMODY: If you look at that, is
20 there a point you wish to make about it? I don't see
21 sitting here reading exhibits at this hour. Is there
22 one paragraph or the other, or one particular point
23 you'd like to make on this?

24 CAPTAIN PITTS: It is a very complex subject,
25 ma'am, but in honor of your request, I'll ask him to

1 just read the second paragraph.

2 MR. CLARK: It would be better, Captain
3 Pitts, if you read the second paragraph, and then he
4 can listen.

5 CHAIRMAN CARMODY: Yes.

6 CAPTAIN PITTS: Well, sir, I'm going to ask
7 his expert opinion as an engineer and as a
8 representative of pilots in the human and machine
9 interface to speak to these, so I'd actually like to
10 hear --

11 CHAIRMAN CARMODY: Well, I think it would be
12 useful if you read it while he would think about his
13 response.

14 CAPTAIN PITTS: Sure, very well.

15 "Although it is often difficult to pinpoint
16 the cause of specific" -- and you have to forgive me,
17 there's a bit of a glare on the right hand side of the
18 screen, maybe we can bring it up right here --

19 "Although it is often difficult to pinpoint the cause
20 of specific aircraft piloting events, coupling events,
21 a majority of severe APC events result from
22 deficiencies in the design of the aircraft, especially
23 with regard to the flight control system, that reverse
24 to adverse coupling of the pilot with the aircraft. In
25 certain circumstances, this adverse coupling produces

1 unintended oscillations or divergences when the pilot
2 attempts to precisely maneuver the aircraft. If the
3 pilot-vehicle system instability takes the form of an
4 oscillation, the APC event is called a pilot-involved
5 oscillation, also known as a PIO. PIOs differ from
6 aircraft oscillations caused by deliberate pilot
7 imposed periodic control motions, such as stick
8 pumping. They are open loop in character, and open
9 loop forced oscillation does not constitute a PIO. If
10 the unstable motions of the closed loop pilot-vehicle
11 system are divergent, rather than oscillatory in
12 nature, they're referred to as either APC events or
13 non-oscillatory APC events."

14 BY CAPTAIN PITTS:

15 Q My question, sir, is, does Airbus test their
16 equipment to consider pilot-involved oscillations?

17 A I think the term pilot-involved oscillation
18 in this text is used exactly in the same base or the
19 same meaning that pilot-induced oscillation. And I
20 already answered to the question about how we test and
21 how the authorities' test pilots look at the
22 susceptibility of pilot-induced oscillation throughout
23 the testing they are doing. We have done a series of
24 tasks that have not shown any tendency to pilot-induced
25 oscillation. In addition of that, they have not been -

1 - ever been a report of the airplane, the rudder axis
2 being -- having a tendency to go to pilot-induced
3 oscillation, or pilot-involved oscillation. For me it
4 has the same meaning as is written here.

5 Q Alright, sir. Do Airbus test pilots receive
6 training concerning adverse aircraft-pilot coupling
7 issues?

8 A They have most probably in their career been
9 subjected to pilot-induced oscillation events. I have
10 personally, and when I was in the military flight test
11 center, I was in charge of prototype fly-by-wire
12 aircraft that had characteristics due to the prototype
13 flight control which were fitted in that airplane,
14 mainly they were very, very slow, with a lot of time-
15 lag, so this airplane was subject -- was PIO-prone. As
16 a matter of fact, we even used it to demonstrate PIO to
17 some other pilots. So most -- I would expect most test
18 pilots to have encountered PIO at some time in their
19 career.

20 Q I'm going to refer to Exhibit 14-C, page 5.
21 Would you bring that up, please? The last bullet in
22 the first paragraph.

23 A "The committee was disturbed by the lack of
24 awareness of severe APC, even among pilots, engineers,
25 regulatory authorities and accident investigators."

1 Q This was a National Research Committee
2 effort. As a test pilot sir, and an important human-
3 machine interface representative, what is your response
4 to this statement?

5 A My response is that at Airbus, PIO issues are
6 addressed on every program we develop.

7 Q Very well. One last Exhibit, ma'am. Please
8 bring up Exhibit 2-X, page 11, please. If you could
9 focus in on figure 13, it's on the right hand side of
10 the page? And Captain Jacob, are you familiar with
11 this report?

12 A I discovered this report when it was put on
13 the Exhibit list at the pre-hearing.

14 Q Alright, sir. I understand it may not -- you
15 may not have had an opportunity to thoroughly research
16 it. Figure 13 highlights rudder movements of a
17 transport category aircraft flying through multiple
18 vortex rings known as pro-instability. As a test
19 pilot, what is your interpretation of this work, if you
20 had a chance to do so?

21 A I have looked at it. First of all, I do not
22 know what pro-instability is. However, from what I
23 have understood from this report is that it is a highly
24 theoretical study. It's a theoretical study based on -
25 - on unverified hypotheses. And in the conclusion it

1 says that testing is needed -- actual testing to
2 support this -- to make sure -- to know if this
3 hypotheses are valid or not. So it's a theoretical
4 study based on hypothetical data.

5 Q And you agree that maybe further testing is
6 needed?

7 A I don't know. I have to look at the -- it
8 seems very, very theoretical.

9 Q Alright, and one last question, sir. As it
10 relates to special conditions in the turbulence
11 criteria, as I asked in the questions yesterday of Mr.
12 Chatrenet, the airplane flight manual and any
13 appropriate special control instructions that may have
14 needed to be included. Would you consider the
15 modifications to the rudder usage that was introduced
16 into the FCOM by Airbus in March of '02 as a special
17 flight condition with a new limitation, or a new
18 prohibited use of the rudder?

19 A I think it is in answer, certainly, to NTSB
20 recommendation following the accident, and I think this
21 kind of information is valid for all transport type
22 aircraft, and as such, should, in the future, be
23 included in training -- in general training for a
24 transport pilot. It's not relative to any specific
25 type.

1 CAPTAIN PITTS: Alright, sir, thank you very
2 much. Thank you, ma'am.

3 CHAIRMAN CARMODY: Yes, turning to the FAA.
4 Mr. Donner.

5 MR. DONNER: Thank you, ma'am, we have no
6 questions.

7 CHAIRMAN CARMODY: And Dr. Lauber with
8 Airbus.

9 BY DR. LAUBER:

10 Q Just two quick questions. Captain Jacob, you
11 were asked about questions about forces observed on the
12 pedals in 587, and specifically with reference to high
13 control forces -- 120 pounds or so. Do you know
14 whether or not such high forces were observed on the
15 initial input to the rudder pedals that the pilot made?

16 A Say again? Sorry.

17 Q Based on Mr. Chatrenet's data that was shown
18 yesterday, the first -- the initial pedal input -- was
19 there any indication there of high control forces on
20 that?

21 A No, not on the initial one.

22 Q Thank you. And my final question, based on
23 that reconstructed time history of the rudder and
24 rudder pedals that were shown yesterday by Mr.
25 Chatrenet, do you believe that the initial control

1 inputs made by the pilot in 587 were consistent with
2 the training received in the AAMP program with regard
3 to use of rudder?

4 A I do believe they are consistent.

5 DR. LAUBER: I have no further questions.
6 Thank you.

7 CHAIRMAN CARMODY: Thank you, moving to the
8 Board. Member Hammerschmidt, any questions?

9 BY MEMBER HAMMERSCHMIDT:

10 Q Just one very quick question. Concerning
11 this whole issue of pilot-induced oscillations, as an
12 experimental test pilot, would you say that the Airbus
13 A300-600 aircraft is any more susceptible to lateral
14 oscillations than would be any other transport category
15 aircraft?

16 A The answer is no.

17 MEMBER HAMMERSCHMIDT: Thank you, sir, that's
18 all I have.

19 CHAIRMAN CARMODY: Member Goglia?

20 MEMBER GOGLIA: No questions.

21 CHAIRMAN CARMODY: Member Black.

22 BY MEMBER BLACK:

23 Q Captain, good morning -- or I guess, good
24 afternoon. Time flies.

25 A Good afternoon.

1 Q Are you familiar with the circumstances of
2 flight 903, an incident in 1997 involving an Airbus
3 300-600?

4 A I was not directly involved in it, but I have
5 reviewed the data, yes.

6 Q Were you aware of it at the time it occurred?

7 A No. I reviewed it later on.

8 Q Okay, that cuts off one avenue, but I'll ask
9 the question anyway. Did it ever occur to you, or has
10 it ever occurred to you since you've been at Airbus, or
11 since you've been in the test flight business, that a
12 pilot might make a doublet without knowing what it was,
13 and what the consequences of that event might be?

14 A I don't see any -- any situation, either
15 normal or in failure, that would require a doublet, and
16 the -- this kind of inputs obviously would, in the
17 situation of panic or something like that, any type of
18 flight control might be possible, but then in this kind
19 of situation whether you are aware or not aware that
20 you should make it or not doesn't make any difference.

21 MEMBER BLACK: Okay, thank you.

22 CHAIRMAN CARMODY: Is that it, Mr. Black?

23 MEMBER BLACK: Yes, ma'am.

24 CHAIRMAN CARMODY: Okay. Thank you. Are
25 there any additional questions from the technical

1 panel? Any of the parties? American, something new?

2 MR. AHEARN: Just one quick question, Madam
3 Carmody. Captain Jacob, have you ever been to the AAMP
4 training program?

5 THE WITNESS: No.

6 MR. AHEARN: Thank you.

7 CHAIRMAN CARMODY: Anyone else? Very good.
8 Then I propose we come back at 2:30 and we'll resume
9 with the next witness. Captain Jacob thank you very
10 much for your testimony. Very helpful to us.

11 CAPTAIN JACOB: Thank you very much.

12 (Whereupon, at 1:45 p.m., the hearing was
13 recessed, to reconvene at 2:40 p.m., this same day,
14 Wednesday, October 30, 2002.)

15

1 been a civil servant with NASA for the past 12 years.

2 Q And what are your duties and responsibilities
3 in your current position, and please list any education
4 and training that you may have received that qualifies
5 you for your position?

6 A I conduct and direct research in support of
7 two national programs, the Wake Vortex Element of the
8 Airport Capacity Program, and the Aviation Safety
9 Program. In the latter, I provide tools and data sets
10 for potential certification of -- for potential FAA
11 certification of look ahead wind shear -- or, excuse me
12 -- turbulence radars.

13 My education is -- I have a Bachelor's in
14 Meteorology from Florida State University. I have a
15 Ph.D. in Meteorology from Texas A&M University. My
16 specializations are computational meteorology and fluid
17 dynamics, with special emphasis on aviation hazards
18 such as modeling of wake vortices, flight turbulence
19 and wind shear.

20 MS. WARD: Madam Chairman, I find this
21 witness qualified and now pass it to Mr. John
22 O'Callaghan for questioning.

23 CHAIRMAN CARMODY: Yes, Mr. O'Callaghan,
24 please begin.

25 MR. O'CALLAGHAN: Thank you, Madam Chairman.

1 BY MR. O'CALLAGHAN:

2 Q Good afternoon, Dr. Proctor. Dr. Proctor,
3 you performed an analysis of the wake shed by the
4 Boeing 747 that preceded American flight 587 out of
5 JFK. Does your work support an encounter of the 747
6 wake by the American flight 587?

7 A Yes, it does.

8 Q And what were the characteristics of the wake
9 at the time or times of these encounters?

10 A Characteristics were that it was 60 to 80
11 percent of its initial strength, and that there were
12 meanders in the wake, but there was no linking
13 instabilities going on at that time, in other words,
14 Crow instability had not set in yet.

15 Q Thank you. At the time of this encounter,
16 can the wake be analyzed or modeled analytically or,
17 given that it hadn't decayed into vortex rings?

18 A Yes, it can be modeled analytically.

19 Q And you actually developed a model for the
20 NTSB?

21 A That's correct.

22 Q How would you characterize the 747 wake at
23 the time of the encounters? Is it a typical wake, or
24 anything unusual or remarkable about it?

25 A Nothing extraordinary about it, other than it

1 occurred in an environment which was favorable for long
2 lasting wakes, but this is nothing out of the ordinary.

3 Q Thank you. And referring to Exhibit 2-X,
4 there's a paper -- it's a paper entitled "An
5 Engineering Study of the Unsteady Response of a Jet
6 Transport During a Wake Encounter and the Transitional
7 State of Potential Crow Instability". Have you had an
8 opportunity to review that paper?

9 A Yes, I have.

10 Q And does the paper in question explicitly
11 purport to describe events that actually did occur or
12 could have occurred during the accident flight?

13 A The paper is flawed because of the
14 assumptions that it made. It assumed that Crow
15 instability had occurred, which our analysis showed
16 that it had not, and two, that the Crow instability had
17 somehow rotated 90 degrees into a vertical plane, which
18 is -- which is never observed and unjustified.

19 Q But does the paper, does it pretend to say
20 that that had actually occurred on this specific
21 accident flight, or is it just postulating this in a
22 general way?

23 A It postulates that it might have occurred.

24 Q And again, you started answering a question I
25 had about whether the assumptions and conditions

1 described in that paper are applicable to the wake
2 encounter. You mentioned a couple assumptions that
3 were flawed. Were there any other assumptions that
4 don't apply to this case?

5 A Another assumption is that the analysis ...
6 no decay had occurred in the vortex, that it was at
7 full strength.

8 Q Whereas your work shows otherwise, is that
9 right?

10 A That's correct.

11 Q So I guess to the point, then, is the
12 phenomena described in the paper relevant to the
13 circumstances of this accident?

14 A No, it is not.

15 MR. O'CALLAGHAN: Thank you, Dr. Proctor, and
16 Madam Chairman, I have no further questions.

17 CHAIRMAN CARMODY: Thank you are there any
18 questions on the tech panel? Any additional questions?

19 Seeing none, alright. Let me proceed then to the
20 parties, and I would suggest an order this time of
21 Allied Pilots to begin, and Airbus, and American, and
22 FAA, if that's agreeable. Captain Pitts, would you
23 like to start the questioning?

24 CAPTAIN PITTS: Yes, thank you.

25 CHAIRMAN CARMODY: Uh-huh. Thank you.

1 BY CAPTAIN PITTS:

2 Q Sir, your discussion mentioned the data used
3 in the development of the model was semi-empirical.
4 Could you identify for us what was empirical and what
5 was inferred?

6 A This is referring to the APA model?

7 Q No, sir, to your model.

8 A My model.

9 Q Yes, sir.

10 A There is no empiricism in the model that I
11 used which developed the data sets -- very low
12 empiricism. It is a Avery-Stokes Code which is
13 developed in a meteorological framework and it does a
14 large ... simulation of the wake vortex phenomena in
15 three dimensions and time.

16 Q And does it then give you sufficient surety
17 to estimate the strength and the possible potential of
18 the Crow instability with that large a degree of
19 generalism?

20 CHAIRMAN CARMODY: Excuse me, we've had some
21 requests Dr. Proctor, for you to get a little closer to
22 the microphone so we can hear your testimony. Thank
23 you.

24 THE WITNESS: Excuse me.

25

1 BY CAPTAIN PITTS:

2 Q Would you like me to repeat the question?

3 A Yes.

4 Q You said that it was general in nature, and
5 not empirical?

6 A The terminal area simulation system, yes. My
7 model.

8 Q That you used.

9 A We used several models in this study. One
10 model to generate the data sets and another model to do
11 the prediction of the wake vortex --

12 Q And based upon the non-empirical basis of
13 that, what degree of surety do you have in your
14 estimates in evaluation of the vortex, then?

15 A I think the greatest uncertainties will come
16 in as far as the input of initial conditions, for
17 example, the initial cross wind profiles and turbulence
18 profiles that were used to initialize the model.

19 Q But it gives you sufficient information to
20 give a determination that Crow instability could not
21 have possibly been developing?

22 A Not if the input is true, and the input came
23 from the flight data recorders of the JAL47 and the
24 587.

25 Q Alright, sir. Your slide presentation

1 material provided in your study does not indicate the
2 derivative model of the Boeing 747 used in the
3 analysis. Which model was that, sir?

4 A I'm sorry.

5 Q Which model of the 747 did you use for your
6 analysis of the derivative data?

7 A We used -- as far as the input data?

8 Q Yes, sir.

9 A We used -- it was the data provided by the
10 NTSB from the analysis of the --

11 Q So it was specific to that 747-400 that
12 preceded the -- it was --

13 A Yes.

14 Q -- exactly --

15 A The JAL, yes.

16 Q Alright. What gross weights -- were the
17 gross weights recorded by the aircraft as reported by
18 the --

19 A The weights were given to us by NTSB.

20 Q If we could bring up Exhibit 13-A, pages 156,
21 and I think it carries over to 157. Slide titled
22 "Three Dimensional TASS Model".

23 A Correct.

24 Q Would you like for us to wait until it shows
25 up on the monitor?

1 CHAIRMAN CARMODY: Yes, I would, and if you -
2 - I don't see it of course, but if you could indicate
3 when it does, what paragraph, what part of the page,
4 our technician could probably find it more quickly, but
5 right now it's not on the screen. I'm sorry -- are you
6 saying there's no -- oh, here it comes.

7 MEMBER BLACK: Is this Exhibit the
8 performance study?

9 CHAIRMAN CARMODY: What was the Exhibit
10 number again, Captain Pitts?

11 CAPTAIN PITTS: 13-A.

12 MEMBER BLACK: Is it the performance study?

13 CAPTAIN PITTS: Yes, sir.

14 MR. CLARK: Okay.

15 CHAIRMAN CARMODY: Well, we're half way
16 there. Need to turn it -- does that look like the
17 right Exhibit?

18 CAPTAIN PITTS: Yes, ma'am.

19 CHAIRMAN CARMODY: Okay.

20 BY CAPTAIN PITTS:

21 Q How was the concluding circulation value
22 derived, Dr. Proctor? Previous page?

23 A I'm sorry, what page are you on?

24 Q Let's use the previous page to that, it would
25 be -- I'm sorry, the subsequent page, page 157.

1 A 157?

2 Q Yes.

3 A Okay, the initial circulation was based on
4 the weight and air speed of -- and the aircraft wing
5 spans of the JAL-47.

6 Q Yes, sir, that was the initial. And the
7 concluding circulation value, how was that derived?

8 A Concluding circulation -- the numerical
9 simulation was initialized with that value, and all the
10 other initial conditions, and the simulation progressed
11 in time and the vortex decayed with time, and then
12 after, say, I think it was about 100 seconds, the value
13 had decayed to the value that's quoted there, which is
14 -- in the text, which is about 80 percent of the
15 initial value.

16 Q And so that was derived from known
17 characteristics of a standard decline or standard
18 degradation of a vortex?

19 A (inaudible)

20 Q I'm sorry, I didn't understand that.

21 A Avery-Stokes determined it. In other words,
22 it was calculated using equations of motions and
23 physics.

24 Q What is the tangential velocity of the vortex
25 that we see in circulation here?

1 A In numerical simulation, the peak was about -
2 - a little less than ten meters per second at the time
3 of encounter.

4 Q Alright.

5 A And that was over a core radius of three or
6 four meters.

7 Q Alright, sir. What is your estimate of
8 potential forces, direction and magnitude generated by
9 the vortex?

10 A I cannot answer that question at this time.

11 Q Is there something that's missing from the
12 information that you need to make that determination?

13 A These data sets were provided or being
14 provided so that more detailed dynamic model analysis
15 can be made, and also they can be used in flight
16 simulator studies as well.

17 Q So those more dynamic models that might be
18 made, do you think they would show different final
19 conclusions based upon this degradation that you
20 outlined for us, and the fact that there could possibly
21 -- was no Crow instability present? In other words --

22 A No, the flow ... would not change, but what -
23 - a person that has an aerodynamics background can do,
24 is then run simulations of what an aircraft would
25 encounter using different trajectories through the

1 vortex.

2 Q I see. In terms of the vortex and what
3 forces it can generate, can you speak to the assumption
4 that the vortex can or cannot create an equal and
5 opposing force in a given area? For instance, on a
6 flight control surface or a surface of a aeroelastic
7 (ph) vehicle?

8 A My background is not in aerodynamics, so I
9 really can't speak to that.

10 Q But in terms to what the vortex is capable
11 of?

12 A I have no -- a very -- circulations there of
13 -- of -- they range from ten meters per second over
14 four meters, or ten meters per second to tangential
15 velocities over four meter decreasing with smaller radii.

16 Q Alright, sir. What conditions do favor Crow
17 instability?

18 A Crow instability is a strong function of the
19 ambient turbulence in the atmosphere. The stronger the
20 turbulence, the sooner Crow instability will occur.

21 Q And that turbulence, then, could that be
22 generated by an aircraft that flew through the area as
23 well, versus an atmospheric condition of turbulence
24 that may be from moving air masses?

25 A Highly unlikely. It's mostly or almost

1 entirely due to the ambient level of turbulence.

2 Q And you're saying that those conditions were
3 not present in the atmosphere on the day of the
4 accident?

5 A From our analysis of the flight data recorder
6 of the 747 which preceded it, we showed very light
7 levels of turbulence, above the atmospheric boundary
8 layer which had an altitude of about 1500 feet.

9 Q Is it possible that we could not see Crow
10 instability and it in fact be present in the
11 atmospheric conditions that existed on the day of the
12 accident?

13 A You would not be able to see, probably, this
14 vortex, regardless of what it was doing at that time.

15 Q I'm sorry, I may have misspoke. I don't mean
16 see with our eyes, I'm talking about see in the review
17 of the data that's available. You spoke earlier to the
18 general nature of some of the information that you had.

19 Is it possible that Crow instability actually exists
20 out there and we can't see it with some of the tools
21 that we have to measure it?

22 A I still don't quite understand the intent of
23 your question.

24 Q In terms of a hazard to aviation, is it
25 possible that we had Crow instability present in these

1 atmospheric conditions which are not conducive to it?

2 A I can't answer that other than our modeling
3 studies and the observations, the years and years of
4 observations that we have, would indicate it was a
5 strong function of the ambient turbulence.

6 Q Last questions. Are you familiar with the
7 FAA wake turbulence separation criteria?

8 A Vaguely, yes.

9 Q Does your understanding of the FAA wake
10 turbulence separation criteria allow you to comment on
11 our current separation criteria?

12 A I know what they are, but I can't really
13 comment on it, no.

14 Q In knowing what they are, do you feel as if
15 we have sufficient separation criteria between
16 aircraft?

17 A Most people believe in the field that the
18 criteria are quite conservative, and this is borne out
19 by the very few accidents that occur.

20 Q So the absence of an accident would suggest
21 that it's safe?

22 A Again, I think this would be probably better
23 addressed to the FAA or people who are responsible for
24 making these.

25 Q In your opinion, sir, does the contemporary

1 science support the application of the same wake
2 separation criteria to an aircraft in trail of a
3 255,000 pound aircraft as that for a aircraft weighing
4 nearly 900,000 pounds?

5 A Would you repeat that, please?

6 Q Yes, sir, I'll be happy to. In your opinion,
7 sir, does the contemporary science support the
8 application of the same wake separation criteria to an
9 aircraft in trail of a 255,000 pound aircraft as that
10 for a aircraft weighing nearly 900,000 pounds?

11 A Again, I would rather not comment on that.
12 I'm not an aerodynamicist so -- nor a policy maker as
13 far as that.

14 Q In your studies of wake vortex, have you seen
15 an effect of aircraft gross weight on the intensity and
16 the strength of a wake vortex?

17 A Yes, the heavier the aircraft, the stronger
18 the wake vortex.

19 Q Alright, sir, and the current science now
20 speaks to heavy aircraft at a weight of 255,000 pounds
21 or greater, correct?

22 A That's correct.

23 Q And are there any gradients to reflect
24 aircraft twice that weight?

25 A I cannot really comment on that question.

1 Q But you would agree that as the aircraft
2 gross weight increases, that it would increase the
3 strength of the vortex?

4 A Yes, it would.

5 Q Alright, sir. And I apologize, I have one
6 more series of questions. How does the pressure vary
7 cross sectionally in a vortex core?

8 A The pressure field will try to balance the
9 tangential velocities, so you can have a very low
10 pressure in the core of the vortex. These vortices are
11 like, I guess, weak mini-tornadoes.

12 Q And does that pressure gradient increase
13 linearly towards the core? In other words, it's
14 stronger --

15 A Probably exponentially drops into the core.
16 The pressure decreases exponentially into the core.

17 Q How would such an area of low pressure affect
18 an aerodynamic surface, if it were encountered? Are
19 you qualified to speak to that?

20 A I am not qualified.

21 Q Alright, sir, I understand. Have you ever
22 had an experience where a core of a vortex coming into
23 contact with an aircraft has made a sound like a thump?
24 In your studies have you seen this?

25 A I'm not aware of such.

1 Q Alright. I'll skip the next question that
2 speaks to aerodynamics. Would it be possible -- and I
3 won't ask you to comment on the aerodynamic properties
4 of the aircraft -- but if there were a low pressure
5 area existing on one side of the aircraft versus
6 another as created by the wake vortex core in a
7 tangential encounter, would it be possible for it to
8 effect enough of an oscillation as you've seen in the
9 presentation of the aircraft performance capabilities?

10 A I would be unfamiliar of how an aircraft
11 would respond to it.

12 Q I understand. One last Exhibit, 13-A, page
13 152. In the depiction of the aircraft's movement
14 relative to the vortex, how much lateral air or system
15 tolerance do you think exists in the placement of the
16 aircraft relative to the vortex?

17 A Probably at least 50 meters.

18 Q Plus or minus 15 meters?

19 A At least.

20 Q I'm -- was that 5-0 or 1-5?

21 A 5-0.

22 Q 5-0, I'm sorry. Is it possible that there is
23 a more tangential motion of the aircraft, then, if we
24 were to move that 50 meters one direction or the other?

25 A Again, I can't really comment to the

1 aerodynamics.

2 Q You didn't place the aircraft in the
3 depiction?

4 A No, I did not.

5 CAPTAIN PITTS: Alright, sir, fine. No
6 further questions.

7 CHAIRMAN CARMODY: Alright, moving -- I
8 believe I said American would be next, Mr. Ahearn,
9 questions?

10 MR. AHEARN: Thank you, Madam Chairman, just
11 a couple topics that I'd like to review with Dr.
12 Proctor.

13 BY MR. AHEARN:

14 Q Good afternoon. Thanks for your time. You
15 talked about the characteristics of what would drive
16 the wake and generate the wake off this aircraft.
17 Other than weight and lift, are there other primary
18 factors that you use to determine the strength of this
19 vortex?

20 A The initial or the calculated at the time of
21 the supposed encounter?

22 Q Well, let's just talk about the initial.

23 A Okay, the initial would be just the function
24 of the weight of the aircraft, its wing span and its
25 air speed.

1 Q Thank you. If the powerful wake vortices
2 generated from this very heavy JAL aircraft in a clean
3 configuration climb out, actually struck the
4 vertical stabilizer -- could it generate a yawing
5 moment?

6 A I really can't comment on the aerodynamics of
7 how the flow would affect the aircraft.

8 Q Okay. Is it possible, with your study, and
9 what you've looked at from the wake off the JAL
10 airplane, is it possible that the JAL vortices could
11 have interacted with flight 587 more than once during
12 the second event?

13 A Yes, it is possible.

14 Q Okay, and then it's part of the size of its
15 wake -- based upon your experience, and obviously your
16 analysis of this event, is the 747-400 wake with an
17 airplane at maximum gross weight, as strong as a wake
18 that we'll ever see in this industry with the aircraft
19 that are flying today?

20 A It is one of the strongest, yes.

21 Q Okay, and then one final topic with you, sir,
22 just on the -- this is an issue associated with the
23 DFDR -- the digital flight data recorder. Are you
24 familiar with the sampling rates on the airplane?

25 A Vaguely.

1 Q Okay, the lateral sampling of rate on the
2 DFDR is four times a second, and with that type of
3 sampling rate, is a wake vortices capable of generating
4 movements with a higher frequency than could be
5 captured at the DFDR sampling rate, that being four
6 times a second?

7 A You could certainly capture the outer
8 circulation of the wake vortex. You may not be able to
9 capture the core or the strong tangential velocities at
10 that small a scale.

11 MR. AHEARN: Dr. Proctor, thank you for your
12 time. Madam Chairman, those are the questions I have.

13 CHAIRMAN CARMODY: Thank you. Moving to
14 Airbus, Dr. Lauber.

15 BY DR. LAUBER:

16 Q Just a couple of questions, Dr. Proctor.
17 Good afternoon. Captain Pitts asked you about the
18 possibility of a low pressure, drop in pressure in the
19 core of the vortex. Would that pressure drop be such
20 that it should be detectable by means of the barometric
21 altimeter on the airplane?

22 A No, it would not because it would be over a
23 very small distance.

24 Q With regard to your modeling, have engine
25 effects been considered at all in the development of

1 the vortex?

2 A No, they have not.

3 Q They have not. Do engines have an effect on
4 vortex development? Engine thrust plume?

5 A Very little.

6 Q You indicated that the -- your data show
7 something between 60 and 80 percent of the original
8 vortex strength with the time of the encounter, is that
9 correct?

10 A That's correct.

11 Q That seems like a large spread -- we've got a
12 20 percent spread here. I'm just trying to get some
13 feel for whether this is a situation where -- what
14 causes the uncertainty in the data?

15 A I ran three different models on this case.
16 Some were semi-empirical. The semi-empirical model,
17 the APA model, is primarily used to predict where the
18 vortex track will go and the circulation of the vortex.
19 It predicted about a 63 percent decrease, I think, at
20 the time of the second encounter. And the large LES
21 code that I used that I was referring to before, the
22 TAAS model predicted about an 80 percent decrease.

23 Q 80 percent decrease --

24 A Excuse me, it was 80 percent of the value.

25 Q Of the original -- a 20 percent decrease.

1 A Yes, and the APA model was 63 percent of the
2 initial.

3 Q Are these so-called two-dimensional field
4 models, either of the techniques that you used?

5 A The APA, I guess you would consider more one
6 dimensional than two dimensional. It's one dimensional
7 and in time.

8 Q Would you say that their utility is probably
9 greatest in determining the theoretical maximum
10 strength of the vortex in any given situation, rather
11 than being applied to an evaluation of the specific
12 situation?

13 A No, I think it would probably give a good
14 estimate. It has been used in some of our NASA field
15 programs and done reasonably well, and the parameters
16 themselves were fine tuned with actual observations.

17 Q Were you here yesterday, Dr. Proctor?

18 A Yes, I was.

19 Q You heard the testimony of Mr. Chatrenet. Do
20 you remember the chart that he put up showing the
21 results of two different approaches to calculating side
22 slip? One was the NY integration method, the other was
23 the aircraft model, the simulation model, and that
24 there was about a one degree difference during a
25 certain period of time in calculated side slip, due to

1 the -- produced from the different models. And he
2 indicated that that could be accounted for by about
3 five knots of lateral wind component. Is that
4 consistent with your 60 to 80 percent strength
5 estimate?

6 A I'm not sure. I don't see the connection
7 between the two.

8 CHAIRMAN CARMODY: Would it be helpful to
9 have the chart you're referring to?

10 DR. LAUBER: Do you recall the chart?

11 THE WITNESS: Vaguely.

12 DR. LAUBER: Vaguely.

13 CHAIRMAN CARMODY: Was it an exhibit?

14 DR. LAUBER: It was a presentation.

15 CHAIRMAN CARMODY: Then if he doesn't recall
16 it --

17 BY DR. LAUBER:

18 Q In effect, if I can just characterize it, and
19 if this doesn't make sense, we'll go on to something
20 else. But at the -- during the encounter that was the
21 subject of analysis by the two methods, the results --
22 the differing results of the two models could be
23 accounted for by assuming a lateral wind component of
24 five knots at the time of this encounter, and this
25 would be during the vortex encounter. For a two second

1 period this lasted. Is that five knot lateral wind
2 component consistent with your estimate of 60 to 80
3 percent of the original strength of the vortex?

4 A I'm still not seeing your point, other than
5 five knots is a very small number and you can probably
6 get that much variation in the ambient atmosphere.

7 Q Okay, well, alright, I think I'll go on to
8 one final question. With regard to the effects on
9 following aircraft, the effect of a wake encounter on a
10 following aircraft is dependent upon, among other
11 things, wing span and mass of the follower, is that
12 correct?

13 A That's correct.

14 Q Do you think it's even possible for an
15 aircraft the size of an A300-600 with about a 150 foot
16 wing span and 340,000 pound airplane, is it possible
17 for a vortex that's 100 seconds old to roll such an
18 aircraft to extreme attitudes, beyond 90 degrees, say?

19 A I have not seen any studies that would
20 support that.

21 Q It would be less, in all probability?

22 A Again, the data sets that we generated could
23 certainly be used to test all these hypotheses.

24 DR. LAUBER: Thank you, Dr. Proctor. No
25 further questions.

1 CHAIRMAN CARMODY: Thank you, FAA, Mr.
2 Donner. Any questions?

3 BY MR. DONNER:

4 Q Thank you, ma'am. Dr. Proctor, just for my
5 own clarification, I may have missed it, did your
6 research indicate one or two wake encounters?

7 A Up to two wake encounters, yes.

8 Q And did you find two wake encounters using
9 both the winds from JAL and from American 587? When
10 they were looked at separately?

11 A The wind from the profile from the 47 was --
12 the JAL 47 -- was quite different from the wind profile
13 from the Airbus, and especially at lower levels where
14 the first encounter occurred, so if you use the wind
15 profile from JAL-47, you only got one encounter. When
16 you use the wind profile from the 57, then you got the
17 encounter at the lower altitudes.

18 Q Did you calculate the duration of each of
19 those encounters? How long did they last?

20 A I did not calculate that, no.

21 MR. DONNER: Okay, thank you very much.
22 Thank you, ma'am.

23 CHAIRMAN CARMODY: Member Goglia, any
24 questions? Member Hammerschmidt does not have any.

25 MR. CLARK: Chairman Carmody?

1 CHAIRMAN CARMODY: Yes.

2 MR. CLARK: I think there was a question
3 raised -- can I follow real quick?

4 CHAIRMAN CARMODY: Yes, we'll come back to
5 us, go ahead.

6 BY MR. CLARK:

7 Q There was a reference earlier about how
8 strong a wake can be from a fully loaded 747. This
9 airplane was at 240 knots. What would happen if that
10 airplane slowed down? What would happen to the wake at
11 a slower speed, such as take off speed or approach
12 speed?

13 A The circulation is inversely related to the
14 air speed, so as the air speed moved down, the
15 circulation would go up.

16 Q And that --

17 A Vortex strength speeds would be more intense
18 with a slower aircraft.

19 Q So if separation standards were set, but the
20 worst condition, the lower speed should be considered,
21 is that what --

22 A Yes, that's correct.

23 Q And the faster we go, I get a lesser wake.

24 A Less intense wake, yes.

25 Q And then just to follow up on what Dr. Lauber

1 was following up on. You stated that the vortex flow
2 field at core was about ten meters, which I think is
3 about 20 knots, roughly, how far out -- and the core
4 had a -- what, a 12 meter -- or a three or four meter
5 radius. How far out would I have to go before that
6 degraded down to a five knot flow field?

7 A About a radius of six or eight meters. Five
8 meters per second, or ten knots, and then half that
9 again and it would be -- double that, excuse me, about
10 20 meters, I guess, something like that.

11 Q 60 feet out from the core, I'm in a five knot
12 flow field.

13 A If that vortex is active that way.

14 MR. CLARK: Okay, thank you.

15 CHAIRMAN CARMODY: Any questions, member
16 Goglia?

17 MEMBER GOGLIA: Yes, I do, Madam Chairman.

18 BY MEMBER GOGLIA:

19 Q In your modeling, did you use any of the data
20 that the NTSB had collected for wake vortex studies
21 that we did several years ago after the US Air 427
22 accident?

23 A No, I did not.

24 Q A more general question. In warming
25 atmospheres, such as we have in the morning, there is

1 definitely a difference in the density of the air, or
2 the behavior of the atmosphere between land and water.

3 In this particular accident, we have both of those
4 forces in play, Jamaica Bay being a very large body of
5 water. Does that factor into your modeling at all?

6 A Our team looked at the observations in and
7 around the airport from several different sources, and
8 we didn't see anything that would suggest a real strong
9 variation above the atmospheric boundary layer.

10 Q And I take it from just the conversation
11 that's occurred thus far, that we didn't have any
12 doppler radar available to us to see what the
13 atmosphere was doing in this area?

14 A The -- I know that the doppler radar data
15 would input into the ... system which was providing
16 some data as well. Now, I don't know what the status
17 of the radar was at that time.

18 Q And you said that the effects of engines have
19 very little effect on the vortices? Is that correct?

20 A That's correct.

21 MEMBER GOGLIA: Thank you, no further
22 questions.

23 CHAIRMAN CARMODY: Member Black.

24 BY MEMBER BLACK:

25 Q Thank you, ma'am. Just a couple, Doctor. Do

1 winglets have any effect on vortices production? Same
2 airplane, same gross, same speed, one with winglets,
3 one without?

4 A I really can't answer that question. I
5 really don't know.

6 Q Has anyone ever looked at that?

7 A I'm not familiar with any study on that.

8 Q What do you think might have caused this
9 difference in wind from the -- the derived wind from
10 the data recorders on the two airplanes with only a few
11 minutes in between them, and a few hundred feet
12 vertical altitude? What could account for that
13 difference in winds between two derived profiles?

14 A I'm very suspicious that one might be
15 incorrect.

16 Q Why?

17 A It's very hard to justify that -- a
18 meteorological scenario that would justify that much
19 difference in the wind profiles for -- for being that
20 close in time and space.

21 Q How does -- what effect does weight have on
22 the intensity of vortices produced? Is it a linear
23 relationship or is it an exponential relationship? Is
24 it easy to quantify that?

25 A The initial circulation is a linear function

1 of weight, proportional to weight.

2 Q Directly proportional in a linear fashion?

3 A That's correct.

4 Q I guess that sort of goes to a second
5 question that might lead to the future. Boeing is just
6 in the process of certifying an increased gross weight
7 747, I guess they're going to call it a 400, and the
8 people at the table here are about to produce one that
9 might go over a million pounds, I think on gross weight
10 at Airbus. Do we need to be reexamining this issue
11 with these much larger airplanes that'll be flying in a
12 couple years?

13 A Most certainly.

14 Q You believe we do?

15 A Yes, most certainly.

16 Q One more I think. This paper that's in the
17 docket that I looked at the other night, it seems to be
18 totally based around this incident, is that correct?

19 A You're referring to 13-A?

20 Q I'm referring to Mr. or Dr. or Mr. Brown's
21 paper.

22 A Oh, okay. Yes, he is.

23 Q It basically took this incident and then
24 generated a scenario, I don't know -- but it generated
25 a scenario about rotation of the vortices during the

1 decay process. I know he mentioned what he's observed
2 in contrails at altitude and that sort of thing. Is
3 this a juried paper? In other words, was this thing
4 peer reviewed before it was published?

5 A No, it was not reviewed.

6 MEMBER BLACK: Thank you sir, I appreciate
7 it.

8 CHAIRMAN CARMODY: Thank you. Are there any
9 additional questions from the technical panel? How
10 about any of the parties? FAA, Airbus, Allied Pilots.

11 CAPTAIN PITTS: Just one more question,
12 ma'am. Mr. Clark reminded me of another variable.

13 BY CAPTAIN PITTS:

14 Q He asked about the speed effect on the
15 intensity of the vortex. What are the other variables
16 that affect the vortex intensity?

17 A The weight of the aircraft, and the wing
18 span.

19 Q If the aircraft were to initiate a climb and
20 increase the wing loading on the wing due to
21 acceleration, due to gravity, would that increase the
22 intensity or the strength of the vortex?

23 A It's primarily -- I mean there can be other
24 very small fluxuations due to flap settings and so
25 forth, but primarily the intensity of the circulation

1 is a function of the weight of the aircraft and the air
2 speed, and the wing span.

3 Q So just to make sure I understand, you don't
4 think the wing loading that would change as a result of
5 the pilot initiating a climb, and the accelerations due
6 to gravity would have an effect on the vortex
7 strength?

8 A No, I do not.

9 CAPTAIN PITTS: Thank you.

10 CHAIRMAN CARMODY: And American, any
11 additional questions?

12 MR. AHEARN: No, Madam Chairman, thank you.
13 Alright, thank you. Let me thank the witness, then.
14 Dr. Proctor, we appreciate your testimony and your
15 moving up at our request. Thank you very much.

16 DR. PROCTOR: Thank you.

17 (The witness was excused.)

18 CHAIRMAN CARMODY: And Ms. Ward, I believe we
19 have a panel coming up.

20 MS. WARD: Yes, I'll go ahead and call the
21 next four witnesses. We have Mr. Robert Jones, Mr. Don
22 Stimson, Mr. Loran Haworth, and Mr. Guy Thiel.

23 Whereupon,

24 ROBERT JONES, DON STIMSON, LORAN HAWORTH, and GUY THIEL
25 were called as witnesses, and first having been duly

1 sworn, were examined and testified as follows:

2 MS. WARD: I'll start with Mr. Jones. Would
3 you please state your full name, your current employer
4 and your business address?

5 WITNESS JONES: My name is Robert Charles
6 Jones. I work for the Federal Aviation Administration,
7 1601 Linda Avenue, Southwest, Renton, Washington.

8 MS. WARD: And what is your present position
9 and how long have you been there?

10 WITNESS JONES: I'm an aerospace engineer for
11 the transport standards staff of the FAA. In the
12 position I'm in, I've been there for three years now.

13 MS. WARD: Could you briefly describe your
14 duties and responsibilities and any education and
15 training that you may have received for this position?

16 WITNESS JONES: My duties include helping to
17 develop standards and rules with respect to mechanical
18 systems, including some flight controls. Part of my
19 duties have included being a member of the flight
20 controls harmonization working group, supporting the
21 system design analysis harmonization working group.
22 I've also support various i-seen (ph) venues that have
23 been over the past several years in that position.

24 I have a Bachelor of Science degree from
25 Arizona State University. My working background, I

1 have 11 years of experience from the Boeing Company,
2 working in the area of flight controls. There I
3 developed system requirements, performed hazard
4 assessments and developed failure modes and effects
5 analysis and fault tree analysis. I was a designated
6 engineering representative for the Federal Aviation
7 Administration while I was there as well. After that I
8 moved over to the FAA and worked in the Seattle
9 Aircraft Certification office for two years.

10 MS. WARD: Do you happen to possess any FAA
11 aviation certificates and do you have any flight time
12 and what kind of aircraft have you flown?

13 WITNESS JONES: I have a private pilot's
14 license, but I haven't flown as pilot in command in
15 many years.

16 MS. WARD: Thank you, Mr. Jones.

17 Mr. Stimson, can you please state your full
18 name, your present employer, and your current business
19 address?

20 WITNESS STIMSON: My name is Donald Curtis
21 Stimson. I'm employed by the Federal Aviation
22 Administration, and the business address is 1601 Linda
23 Avenue, Southwest, Renton Washington.

24 MS. WARD: And what is your present position
25 and how long have you been in that position?

1 WITNESS STIMSON: I'm currently the acting
2 manager for the Airplane and Flight Crew Interface
3 Branch. I've been in that position since October first
4 of this year.

5 MS. WARD: And could you also please describe
6 your current duties and responsibilities and any
7 education and training that you have for your current
8 position?

9 WITNESS STIMSON: Certainly, In that
10 position I manage and have overall supervisory
11 responsibilities for the Branch, which is responsible,
12 primarily, for developing and maintaining the
13 standards, policies and guidance relative to issue
14 areas such as airplane performance and handling
15 qualities, human factors, electrical avionics,
16 autoflight, communication and navigation systems, as
17 well as software.

18 I received a Bachelor of Science degree in
19 aerospace engineering at the University of Virginia. I
20 received a Master's Degree in aerospace and
21 astronautics in 1983 from the University of Washington.

22 I was employed by the Boeing Company for 11 years as
23 an aerodynamics performance specialist, including
24 flight testing responsibilities, also served as an FAA
25 designated engineering representative during that time.

1 For the last 11 years I've been employed by the
2 Federal Aviation Administration as an aerospace
3 engineer, with responsibilities for performance
4 requirements and handling quality requirements for the
5 development of standards, policies and guidance
6 pertaining to those.

7 MS. WARD: Do you happen to have any aviation
8 certificates, flight time and what kind of aircraft?

9 WITNESS STIMSON: No, I do not.

10 MS. WARD: Thank you, Mr. Stimson.

11 Mr. Haworth, can you please state your full
12 name, your present employer, and your current business
13 address?

14 WITNESS HAWORTH: My name is Loran Alan
15 Haworth, and I work for the FAA. My business address
16 is 1601 Linda Avenue, Southwest, Renton, Washington.

17 MS. WARD: And what is your present position
18 and how long have you been in that position?

19 WITNESS HAWORTH: My present position is
20 human factors specialist, and essentially that means
21 working on policy.

22 MS. WARD: And what are your current duties
23 and responsibilities and also would you please tell us
24 of any education and training that you received to
25 qualifies you for your current position?

1 WITNESS HAWORTH: I came to the FAA
2 approximately two years ago, and since that period of
3 time I've been working both, as I mentioned, on policy
4 and certification programs. Prior to that time I was
5 at NASA Ames, working with DOD at NASA Ames. I was an
6 engineering research psychologist. Also spent about
7 ten years as an engineering test pilot, and I have a
8 background -- a B.A. and also an M.A., both from the
9 Departments of Psychology, one from the University of
10 Northern Colorado, one from Western Washington State
11 University. And I have several hours of flight time in
12 addition.

13 MS. WARD: Could you tell us what type of
14 aircraft you've been certified in and any certificates
15 that you have?

16 WITNESS HAWORTH: The best way to start,
17 probably, is just talking about my certifications. I
18 have several aircraft qualifications. Essentially from
19 a certification standpoint, or qualification
20 standpoint, I have a commercial in both airplane and in
21 helicopter. I have an instrument in both airplane and
22 helicopter, glider, and also instructor pilot.

23 MS. WARD: Thank you, Mr. Haworth.

24 Mr. Thiel, could you please state your full
25 name, your present employer, and your business address?

1 WITNESS THIEL: I'm Guy Thiel. I work for
2 the FAA at the Los Angeles Aircraft Certification
3 Office. The address is 3960 Paramount Boulevard,
4 Lakewood, California.

5 MS. WARD: And what is your present position
6 and how long have you been in that position?

7 WITNESS THIEL: I'm a certification test
8 pilot. I've been in the position with the FAA for 14
9 years.

10 MS. WARD: And what are your current duties
11 and responsibilities and any education and training
12 that you may have received that qualifies you for your
13 current position?

14 WITNESS THIEL: I basically do flight tests,
15 make evaluations of airplanes to make sure that they
16 comply with the FARs. I have a -- specialize basically
17 in performance, collecting data for performance of the
18 airplane, for the flying qualities of the airplane, and
19 what takes most of my time is working the man/machine
20 interface.

21 MS. WARD: Since you're a test pilot, go
22 ahead and list the aviation certificates that you have,
23 any flight time and aircraft that you've flown?

24 WITNESS THIEL: To continue -- I have an M.S.
25 and a Master of Science and a Bachelor of Science in

1 aerospace engineering. I have about 1000 hours of
2 commercial time, then I went in the Air Force for 20
3 years. I flew T-38s as an instructor, C-130s in the
4 Tactile Airlift Command. I then went to test pilot
5 school, graduated from test pilot school and was a test
6 pilot school instructor for two years, and then
7 finished a number of programs in the Air Force.

8 I have an airtransport pilot rating. I have
9 MD-80, MD-11, Boeing 737, Boeing 777, and Airbus A320
10 type ratings, and I'm also a glider pilot.

11 MS. WARD: Thank you, Mr. Thiel.

12 Madam Chairman, these witnesses are now
13 qualified, I'd like to pass over to Dr. Malcolm Brenner
14 for questioning.

15 DR. BRENNER: We appreciate your being here.
16 The topic of this session, of this portion was to talk
17 about the certification issues, human performance
18 issues in terms of flight controls. I think there was
19 a sense among the parties in preparing, that it would
20 be helpful to have your wealth of backgrounds
21 represented. So what I'd like to do is address most of
22 my questions to the panel, and among yourselves,
23 perhaps, one person can lead, and then if there's other
24 thoughts, we'd appreciate it.

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QUESTIONING OF MR. STIMSON

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BY DR. BRENNER:

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Q A general question. What are the requirements -- can someone lay out the requirements for certification of handling quality of rudder systems, specifically, on transport category airplanes?

A I can talk to the handling qualities requirements that end up driving flight control systems design. The requirements I'm talking about are in 14 Code of Federal Regulations Part 25, which is the transport category airplane certification airworthiness requirements. And I can give you a brief overview here, but of course they are quite detailed and complex, so I recommend that you also refer to the 14 CFR Part 25.

Basically, the handling quality requirements are divided into control requirements, controllability and maneuverability; trim requirements; and stability requirements. For the rudder axis, for example, directional control, I'll go into those first. There's first the overall general controllability requirement.

There are four controllability requirements that pertain to the rudder axis, and the first one is a general controllability requirement that Mr. Jacob

1 touched on earlier, which pertains to all three axes,
2 and that is that the airplane must be safe,
3 controllable and maneuverable throughout the operating
4 envelope under any probable operation condition, which
5 includes conditions such as engine failure, without
6 requiring exceptional piloting skill, alertness or
7 strength, and without danger of exceeding the limit
8 load factor of the airplane.

9 There are specified allowable maximum pilot
10 force limits specified in the rule that are used to
11 comply with the requirement that it not take
12 exceptional pilot strength. That portion has
13 quantifiable allowable force limits in each axis.

14 Then, to go on with the other three
15 controllability requirements, one is an engine out
16 controllability requirement that says that the airplane
17 should have sufficient yaw control with an engine
18 inoperative, to make reasonably sudden heading changes
19 of up to 15 degrees in either direction, into or out of
20 the inoperative engine.

21 Further, the airplane must show that it has
22 sufficient control capability to make crosswind
23 takeoffs and landings. And there is a minimum
24 crosswind specified that for this airplane, it would
25 have to demonstrate at least a 20 knot crosswind

1 capability. That's the minimum. Basically, for -- to
2 operate the airplane at higher crosswinds, the
3 manufacturer typically will demonstrate higher
4 crosswind values than that.

5 And the last controllability requirement is
6 one that was also discussed a bit earlier, and that is
7 that the minimum control speeds must be demonstrated in
8 various phases of flight to be the minimum speed that
9 the airplane could be recovered after a sudden engine
10 failure and maintain straight flight.

11 The trim requirement, basically it generally
12 says that trim must be able to be maintained throughout
13 the flight envelope in normal operating conditions.

14 And then there are four stability
15 requirements having to do with the directional
16 stability of the airplane. One, again, is the general
17 requirement that applies to all three axes, that there
18 must be positive stability. Then there's specific
19 requirements for each axis.

20 For the rudder, the first one is with the
21 rudder free in a yaw condition, it must recover --
22 return to straight flight with the rudder free. The
23 second one is -- and it's a combined lateral
24 directional stability requirement, and the reason for
25 that is that lateral directional stability is really a

1 coupled mode. It's very difficult to have roll without
2 yaw and yaw without roll. So the lateral directional
3 is covered together. With that requirement, that is
4 the requirement that steady heading side slips must be
5 flown throughout the envelope, from very low speeds out
6 beyond the maximum operating speed of the airplane.
7 And it must be shown that the rudder and aileron forces
8 and displacements are proportional to the angle of side
9 slip that's generated. And that must be demonstrated
10 throughout the range of side slip values that are
11 appropriate to the operation of that airplane. And
12 again, in that range of side slip values, the factor of
13 proportionality between the angles -- the displacements
14 and forces in side slip angle must be within safe
15 limits. At greater side slip angles, beyond that which
16 would be normal to the operation of the airplane, all
17 the way out -- we test all the way to full rudder
18 application, regardless of whether the airplane can
19 actually maintain a steady heading side slip in that
20 condition, and demonstrate that the rudder forces don't
21 reverse and we don't have any bad characteristics.

22 Control harmony has been discussed previously
23 and that gets in -- that's where it gets assessed,
24 principally, in this requirement of conducting steady
25 heading side slips.

1 And then the final stability requirement for
2 the rudder is that the airplane, in a dynamic mode, the
3 dynamic stability of the airplane has to be positive.
4 For any mode except for the Dutch roll, it must be
5 heavily damped, and the Dutch roll has to be positively
6 damped with the controls free and easily returned to --
7 or reduce the oscillation with the pilot using normal
8 techniques if the controls are not free.

9 So those are basically -- in the rudder axis
10 -- those are basically the requirements.

11 Q Thank you very much. You mentioned there is
12 some quantification standards for rudder certification.
13 Could you review those?

14 A In the rudder axis, the primary quantifiable
15 requirement has to do with the maximum forces that can
16 be allowed to be taken credit for in certifying the
17 airplane for various maneuvers. For instance, for
18 minimum control speed, you either go out to the rudder
19 limit, the stop, if you will, or there's a maximum
20 force that you're not allowed to go beyond and take
21 credit for, and that force is 150 pounds. So in any of
22 these tests that demand full rudder, in terms of
23 controllability, from the control side, you're limited
24 to a maximum of 150 pounds of force.

25 Now, on the stability side, when we examine

1 the stability of the airplane, we -- in the steady
2 heading side slips for example and out the full rudder,
3 you have to either go out to the stop, or in case the
4 pilot is capable of exerting more effort, you have to
5 go out to 180 pounds of force in that axis.

6 Q And where there are no quantification
7 standards, would you do the evaluations by pilot
8 judgement, or how would you do that?

9 A They're qualitative judgements made by the
10 flight test pilot.

11 Q What are the quantification standards for
12 rudder certification compared with quantifications
13 standards for wheel and column?

14 A From the longitudinal axis, again we have
15 controllability, trim and stability requirements. For
16 controllability, again, there is a maximum force that's
17 allowed to be taken credit for in showing the
18 controllability. And controllability requirements for
19 the longitudinal axis have to do with -- for instance,
20 if you are at a reduced speed, close to the stall
21 speed, you have to be able to put the nose down and
22 recover back to your trim speed, from any speed down to
23 the stall speed so that you have adequate longitudinal
24 control to do that.

25 Then, under configuration changes, speed

1 changes, changes in thrust, you have to be able to show
2 that you can maintain steady flight in those conditions
3 without exerting more than 50 pounds force on the
4 control column. And that 50 pounds is in the
5 requirement, 25.143, the controllability requirement as
6 the maximum force that can be taken credit for exerted
7 by one hand on the control column. So that's a case
8 where you might be using the other hand to make
9 adjustments either to the configuration of the airplane
10 or for other reasons.

11 Q In general, are the quantification standards
12 for rudder as prescribed or as broad as they are for
13 the other controls, or less so?

14 A Oh, they're really very similar. There's
15 probably only one area where the -- in the longitudinal
16 axis - where there is probably one more quantifiable
17 parameter than there is in the other axes, and that has
18 to do with speed stability.

19 In the longitudinal axis, there's a speed
20 stability requirement, basically from a trim speed, you
21 have to reach and -- to maintain and obtain lower
22 speeds you have to exert a pull on the column. To
23 reach and maintain higher speeds, it has to be a push
24 throughout the stable trim range. Now, as you get to
25 lower and lower speeds, it has to still be a pull and

1 at higher speeds, it has to still be a push. That
2 gives you a gradient, basically, of stick force versus
3 speed change.

4 There are a couple of requirements that
5 pertain to the gradient of that curve. One is, first
6 of all, there has to be basically positive at all
7 points, so it's a local slope type of issue. The
8 second is, is that in the stable speed range, there has
9 to be an average slope to that curve of at least one
10 pound for every six knots of speed change. So that's a
11 quantifiable -- I guess that's a numerical parameter
12 that's not present in the other axes.

13 Q Are there examples of rudder design issues
14 that have become certification concerns in transport
15 category?

16 A Yes, certainly, there are some issues that
17 have come up over the years. I think probably the most
18 recent one that I recall had to do with control harmony
19 on a particular airplane that, in doing the steady
20 heading side slips, which is a primary way of
21 evaluating control harmony, this particular airplane
22 reached a condition where full lateral control was used
23 before you got very much rudder -- before you used very
24 much rudder, and it was to an extent that there was
25 quite a bit of rudder left, and it raised the issue of

1 whether or not the amount of lateral controls, was
2 consistent with the amount of directional control that
3 was available to the airplane.

4 QUESTIONING OF MR. THIEL

5 BY DR. BRENNER:

6 Q Thank you. I guess I wanted to ask on the
7 more human performance side, I guess the more
8 experimental test pilot side, what kind of human
9 performance issues are involved in evaluating forces in
10 rudder systems?

11 A When we do specific, like steady heading side
12 slips, we would basically want to make sure that we
13 have increased forces symmetrically throughout the
14 whole side slip and back -- that would be the most
15 important thing, in other words, that you wouldn't have
16 a gradient change in the middle of that, or that you
17 wouldn't have some bad characteristic at the end -- as
18 you get towards the end of the -- looking at the side slip.

19 Q What would you look for in break-out force?

20 A Break-out forces, it's really been discussed
21 the last couple days a lot. I think the Airbus
22 philosophy of having enough break-out force that you
23 wouldn't inadvertently hit the pedal and disturb the
24 airplane is a good one. I certainly couldn't put a
25 number on that. I wouldn't have a feel for that. So

1 that would be the break-out force, and at that point,
2 you have to understand when we do these tests, we do
3 them at a very slow, methodical way, so we would start,
4 you know, with our feet on the rudders, decide which
5 way we're going to go to do the side slip, and very
6 carefully and slowly start to ease -- put force on the
7 rudder pedal until a point where we get some motion
8 from the rudder. Then we'd all aileron to keep the
9 heading steady. Stop at that point, take some data,
10 add a little bit more, stop, take that data, until we
11 get to the very end.

12 Q Now earlier in the hearing we were talking
13 about the ratio of break-out force to maximum force. I
14 think we were looking particularly at a range in the
15 variable stop design we were discussing on the
16 airplane, where you had a one and a half ratio to one.
17 Specifically, I think we were talking that a maximum
18 deflection of this air speed be produced by 32 pounds
19 pressure, break-out was 22 pounds pressure. Are there
20 guidelines as to what a ratio should be between the
21 two?

22 A There are not.

23 Q With this type of design, would there be a
24 danger that a pilot might inadvertently command full
25 rudder when he intended only to make a small rudder

1 input?

2 A I think Captain Jacob really talked about
3 this very well. In fact, pilots don't fly airplanes
4 like that. Pilots fly airplanes -- they basically want
5 to do something, they put an input in, and if it's not
6 enough, they put more in, if it's too much, they take
7 it out. So they respond to the motion of the airplane.

8 So if I was going to add rudder, I'd have to have a
9 reason to add rudder, and I would add rudder sufficient
10 to do what I want to do, and that would probably be
11 coordinate the airplane.

12 Q Do you think a pilot, with this type of
13 design, with this ratio, would need training to make
14 precise entries, or do you think that it would be
15 intuitive enough that a pilot could use it
16 appropriately without training?

17 A I think a pilot, by the time he gets to this
18 stage of the game and is an air transport pilot, should
19 have a lot of background in how to use rudder and how
20 to apply it. I don't think the average person would
21 stomp on the rudder. I think he would slowly add pedal
22 as he needed it. So I wouldn't think at this stage
23 that you wouldn't need any training.

24 Q And we also heard testimony that line pilots
25 may not receive any ground or simulator training in the

1 design factors of the rudder system. So in a variable
2 stop situation, you might have a case of a line pilot
3 who's making input at this speed for the first time, in
4 turbulent conditions without this type of background.
5 Under these conditions do you think the pilot would
6 have any difficulty making precise inputs?

7 A Again, you'd have to have a reason to make an
8 input at a speed that he's never used before, in other
9 words, an engine failure or something along those
10 lines, and again, I think he would respond to what he
11 needed. If you have an engine failure, you would,
12 first of all, level the wings, and the second thing you
13 do then is coordinate your steady state with as much
14 rudder as is required to center the ball. So I would
15 think not.

16 Q And we were talking this morning also about
17 the control harmony. Does control harmony apply to
18 both force and displacement?

19 A Yes.

20 Q And as described, we were talking about the
21 variable stop design, how does that maintain control
22 harmony, based on the discussion you've heard?

23 A Well, again, it was discussed earlier -- I
24 think the discussion was right on. As you're doing
25 these steady heading side slips all the way from

1 minimum speeds to maximum speeds, you're again doing it
2 in a very slow, methodical way, and you're adding
3 enough rudder just to get some movement and then
4 balance it with the aileron to maintain a steady
5 heading side slip, and you'd do it all the way to the
6 very end. As long as the harmony is there between the
7 two axes as you do that test, it is an acceptable test
8 and complies with the rules.

9 Q And I guess we discussed that at the air
10 speed we were looking at, this design used one third of
11 the full travel range, and I guess there was a
12 question, is there a danger the line pilot might
13 mistake this limited travel range for a jammed rudder
14 or some other problem. Does that seem like it might be
15 a problem?

16 A Again, I think by the time he's where he is,
17 in flying the airplane and with the experience he gains
18 as he continues to fly, he should have an idea of how
19 the airplane design and that he has a limiter of some
20 kind. I would hope that -- and how that kind of works.

21 So, again, I think, at that air speed, even though
22 it's an air speed he wouldn't use very often, would
23 have to use it. I think he would use what was required
24 as opposed to making a large input without thinking
25 about what he's doing.

1 Q Thank you, and I understand then, that this
2 would not raise certification issues -- these type of -
3 -

4 A No, I don't have any experience on the A300
5 airplane at all, but I have experience in other
6 airplanes that are all different types, and none of the
7 ones in the transport category have had a problem that
8 I would say would be unacceptable. I've only seen bad
9 characteristics on fighter type airplanes.

10 Q What are pilot-induced oscillations?

11 A What I'm going to do is since that's already
12 been defined by at least one person, maybe two, what I
13 thought I would do is read to you what -- we have a
14 manual that we use. It's called -- it's a manual on
15 flight test techniques on how to gather data. It's
16 called Aircraft -- it's AC25-7A, and this is the
17 document where the criteria for doing PIO testing has
18 been put. So in this document -- and again, this is a
19 very complex subject, and there's a lot of definitions
20 out there, but I wanted to do is for the record, is to
21 read to you what it says, and that's just the first
22 sentence. It says, "The classic PIO, commonly referred
23 to as pilot-induced oscillation" -- and by the way,
24 there's a number of PIOs out there. There's pilot-
25 induced, there's pilot in the loop, there's all these

1 different names that have been used, but PIO is the
2 only thing anybody really understands -- "is considered
3 to occur when some airplane's response metric" -- that
4 would be pitch or roll -- "is approximately 180 degrees
5 out of phase with the pilot's control input."

6 So basically what you have is the pilot is
7 making an effort to do something with -- let's say,
8 pitch -- and then instead of getting what he expects to
9 get, he gets a motion that he doesn't expect. So when
10 that happens, he could then reverse what he's done and
11 that gets him out of phase 180 degrees. Once he gets
12 out of phase 180 degrees, if he continues in that vein,
13 you then have an oscillatory PIO.

14 Q And how does the FAA evaluate PIO
15 certification?

16 A We put most responsibility on the
17 manufacturer, so when his certification program begins,
18 we sit down with the manufacturer, we discuss all the
19 different requirements that he's got to do, and of
20 course one of them is he has to make sure that the
21 airplane is PIO-free. He doesn't want a PIO any more
22 than we do. As a matter of fact, if you had a PIO,
23 there'd never be a discussion. It's always the stuff
24 in the middle that's difficult, when you're around the
25 ragged edge.

1 So he would explain to us what his program
2 would be to make sure the airplanes are PIO-free, and
3 of course, the more fly-by-wire you get, the more
4 difficult it is and the more tasks he's got to do
5 because those airplanes that have that characteristic
6 tend to be more PIO-prone than a mechanical airplane.
7 So he would tell us what he's going to do, and then we
8 would basically meet occasionally. He would hopefully
9 tell us that -- we almost would be sure that he would
10 tell us if he's found some problems, tell us what he's
11 doing. We have discussions with the test pilots all
12 the time.

13 So at the end of that development program,
14 they would then tell us that they have seen nothing or
15 whatever, so then we would start our certification
16 testing, which wouldn't start off with PIO. It would
17 be all the normal tests would be done. Of course, we
18 would be looking for anything that would be susceptible
19 to PIO as far as flying qualities, or anything else in
20 the flight envelope.

21 At the end of that, if we've seen nothing,
22 and they've reported nothing, we would do two tests.
23 We would do one test at cruise speed, which would be a
24 pitch and roll tracking task, and then we would do
25 offset landings. Those are the two tests that we would

1 do if everything goes well. If they have a problem,
2 then we would explore, and we would negotiate and we
3 would figure out how to solve the problem.

4 Q Could you describe the two tests briefly,
5 please?

6 A The airplane would be up around a cruise mach
7 number, and that's a good place to do one, everybody
8 agrees, because that's where problems have been seen in
9 the past. And we would -- there's a number of ways of
10 doing something like this. You could do it purely in
11 the pitch axis at first, and then introduce roll. The
12 best way to do it is to have a display put in front of
13 the pilot and this display is programmed to go through
14 maneuvers, and you basically just follow the display
15 through the maneuvers, and you'd be going through a
16 pitch and a roll, probably all the way up to, I would
17 say, plus or minus ten degrees of pitch and roll angles
18 maybe up to 30 or 40 degrees. And you would be
19 tracking this -- you would be tracking a -- it looks
20 like a little airplane symbol or whatever, and you
21 would track that as tightly as you possibly could. In
22 other words, you would very aggressively track this
23 target so you're trying to close the loop. That's
24 where the idea of pilot in the loop comes, so you have
25 a task to perform. You're tracking this as tightly as

1 you can, and that's the way you flush out PIOs. And if
2 you've ever seen one, you'd know it when you found one.

3 QUESTIONING OF MR. HAWORTH

4 BY DR. BRENNER:

5 Q I think the next few questions will be to Mr.
6 Haworth, the member of the human performance group. We
7 talked earlier about the vertical motion simulator --
8 the NASA vertical motion simulator recreations of the
9 accident information -- the FDR and the CVR information
10 -- and as someone who has this background and was
11 involved in this trial, I want to ask your impressions
12 as well. We talked about the second notable event, the
13 one that led to the accident and the observation that
14 the group agreed to that they did not observe a visual
15 or acceleration cue that would lead a pilot to apply
16 the observed initial magnitude of wheel and pedal. Was
17 this your impression as well?

18 A Yes, that's my impression of the second
19 event. In fact, I think the human performance group
20 went further to say that it was barely perceivable. In
21 fact, during the simulation runs, on occasion I
22 actually held onto the controls very tightly to see
23 whether it was cab motion was generated first or
24 control motion, and it was very difficult to tell,
25 because if it did occur, it occurred more

1 simultaneously with the control inputs.

2 Q So basically, then, there were no dramatic
3 accelerations of the sort that you might think would
4 have been correlated with the magnitude of the --

5 A We could not determine a triggering event.

6 Q And another one of the trials that we talked
7 about, the VMS trials simulated the movement of the
8 rudder pedals as they would have been displayed on a
9 ratio changer system. What was your impression of this
10 compared to the same movement of the rudder pedals
11 under the variable stop system?

12 A Much like Armand Jacob mentioned this
13 morning, when you went from an approximately three or
14 four inch displacement -- I'm talking about stop to
15 stop -- on the rudder pedals to approximately eight
16 inches stop to stop, the velocity is quite higher, and
17 in this particular case we have to remember the
18 controls are being back-driven, so we were trying to
19 basically place our hands and feet on the controls and
20 just follow through those control actions. And when
21 the velocity increased because most of these motions
22 were fairly rapid anyway, I think something like 30
23 degrees per second, it literally just threw my feet
24 right off the pedals

25 QUESTIONING OF ENTIRE PANEL

1 DR. BRENNER: You've been here since the
2 beginning of the hearing, we've been discussing a lot
3 of design issues. Is there anything that you've heard
4 that raises certification concerns, concerns about
5 controllability without unusual alertness, strength or
6 skill, or any of the other as we discussed? Perhaps
7 each one of you could say something about any
8 observations from the hearings so far.

9 WITNESS JONES: >From the things I've heard,
10 generally the information that's been presented seems
11 accurate for the types of rudder control systems that
12 I've had experience with, and similar types of rudder
13 control systems have all met the requirements of the
14 FAR Parts, both from the handling qualities point of
15 view, and from the design analysis, reliability point
16 of view. So I haven't heard anything that really gives
17 rise to me of any issues with the compliance or the
18 design of any of these systems.

19 WITNESS STIMSON: I guess I'd have to say
20 that I don't really have anything to add to that.

21 WITNESS THIEL: >From what I've heard
22 throughout the hearing and Captain Jacob's discussion
23 today, I would agree that I don't have anything to add
24 to that either.

25 WITNESS HAWORTH: I don't think at this point

1 I would have anything to add. However, I must say that
2 the human performance group is going through a process
3 of eliminating different possibilities, just like you
4 would in physical evidence, to find out if there is --
5 certain considerations are warranted that might be
6 built upon later on, based on facts and findings.

7 DR. BRENNER: Thank you very much. Madam
8 Chairman, I believe John O'Callaghan has some
9 additional questions.

10 CHAIRMAN CARMODY: Fine, please proceed.

11 MR. O'CALLAGHAN: Thank you, Madam Chairman,
12 and good afternoon, gentlemen. Just as Mr. Stimson
13 suggested, I'm going to be referring to some of the
14 Part 25 rules, so I'll ask Mr. Goldberg to bring up the
15 PowerPoint on those, please, Exhibit 7E. Thank you.
16 So probably Mr. Stimson would be the appropriate one
17 for this, but whoever wants to take it, feel free.

18 QUESTIONING OF MR. STIMSON

19 BY MR. O'CALLAGHAN:

20 Q What I show up there are two FARs that govern
21 the -- parts of the FARs that deal with part of the
22 longitudinal and directional stability requirements and
23 I'm just wondering if you could just briefly explain
24 the reasons for those requirements, and in particular,
25 why the longitudinal speed stability requirement has a

1 quantitative value or limit for the factor of
2 proportionality as you mentioned earlier, whereas the
3 directional axis does not.

4 A Sure, the reasons for the requirements I
5 think I alluded to a little bit earlier, in that
6 they're both stability requirements. In the
7 longitudinal axis it's a speed stability, basically
8 speed stability requirement that the pilot should be
9 aware of speed changes and he's made aware through the
10 forces on the stick.

11 The 25.177 is a directional and lateral
12 controllability -- stability requirement, and as I
13 alluded to earlier, those axes are typically coupled.
14 It's very difficult to separate directional stability
15 from lateral stability, and so it, in the same sense,
16 is a stability requirement for the other axis in that
17 we don't want to see bad qualities that result in, for
18 instance, reversals in rudder forces that may be caused
19 by things such as fin stall or rudder hard-overs type
20 of situations.

21 Now, how they evolved the way that they are -
22 - the predecessor regulations to Part 25 were contained
23 in civil air regulations 4B -- CAR 4B, and those date
24 back to the early 1950's. There was a -- and in that
25 time period, of course, was the origin to these

1 requirements, and these requirements were very similar
2 to what they are today. Probably the most notable
3 difference is that the longitudinal stability
4 requirement was that any significant speed change be
5 perceptible to the pilot through stick force change.
6 And that -- consistent with how the static directional
7 and lateral stability requirement specifies that
8 basically your rudder control forces and displacements
9 should be proportional to the side slip angle. The CAR
10 4B original requirement for static longitudinal
11 stability was that the stick force versus speed curve
12 should be positive and should be proportional.

13 Now, in 1962, there was an amendment made to
14 CAR 4B, the 12th amendment to CAR 4B is where the first
15 time that the gradient was actually specified in terms
16 of a quantitative value. And the reason that was given
17 at the time is that it was very difficult to administer
18 the requirement from a compliance point of view of what
19 was perceptible. And so at that time it was proposed
20 to use, I think at that time it was actually a half a
21 knot for three pounds, which is the same gradient as a
22 pound for six knots -- excuse me, a half pound for
23 three knots which is now a pound per six knots. That
24 was the time period in which it was changed.

25 The reason it was changed was basically an

1 administrative compliance difficulty in negotiating
2 over what was perceptible. And those same issues
3 haven't given rise to any concern about the static
4 lateral direction stability requirement.

5 Q Okay, thank you. And looking more closely
6 then at 177, where it says that the factor of
7 proportionality has to be within limits necessary for
8 safe operation throughout the range of the side slip
9 angles. I think Mr. Thiel talked about it a little bit
10 earlier, but could you explain, perhaps again, how
11 exactly that factor of proportionality is determined to
12 be within the limits, safe limits, essentially?

13 A Sure, it's a qualitative flight test
14 evaluation and that has to do with the control harmony
15 issue as well.

16 Q And what are the maneuvers used to
17 demonstrate that, and are any of the maneuvers involve
18 rolling the airplane with the rudder?

19 A It's a steady heading side slip maneuver that
20 is used to determine what the factor of proportionality
21 is in that area, and that's where the requirement --
22 the requirement applies to side slip angles that are
23 appropriate to the operation of the airplane, which
24 generally, actually we go out to -- we conduct these
25 steady heading side slips out to greater side slip

1 angles than we really expect to see in operation of
2 that airplane. Typically, for a transport category
3 airplane, we go out to side slip angles of about 15
4 degrees or so.

5 Now, beyond that range of values that are
6 appropriate to the operation of the airplane, we will
7 go all the way out to full rudder. If, for that
8 particular design, the airplane has more lateral
9 control -- excuse me, more directional control power
10 available to do it than lateral control power, you will
11 end up in a roll situation at the end of that test.

12 Q Okay, but there are no specific dynamic type
13 maneuvers induced with the rudder that are used in the
14 evaluation of that factor of proportionality. Is that
15 correct?

16 A Could you restate the question?

17 Q I say in the demonstration that the factor of
18 proportionality is safe, the only maneuver I heard you
19 mention was the steady heading side slips. And those
20 are the only ones? There are no dynamic maneuvers that
21 are used in the evaluation of that factor of
22 proportionality?

23 A For that particular requirement, it even
24 states specifically that it's done in steady heading
25 side slips.

1 Q Alright. Thanks. If we could have the
2 second page of that PowerPoint that has 25.147 on it
3 please -- on the screen? Question about that. I'll
4 wait for that to come up. You have a problem with the
5 PowerPoint -- the second page of the one that was just
6 up there? Well, while we're waiting for that to come
7 up, I'm sure Mr. Stimson you're familiar with the FAR,
8 so I'll just go ahead and ask the question. Basically,
9 the FAR 25.147(e) deals with -- it's also on page 23 of
10 Exhibit 7-E if you need to refer to it -- that has to
11 do with roll control, and I'm just wondering how are
12 the requirements of that section demonstrated and can
13 rudder be used during the demonstration?

14 A That particular demonstration says that you
15 should have enough -- this is with all engines
16 operating is the normal operating condition -- that you
17 need to have enough roll power to be able to conduct
18 crosswind take offs and landings and yet be able to
19 adjust for gusts and other operating conditions such as
20 that. And then beyond that, it says that all the way
21 out to the maximum speed, that we demonstrate the
22 stability characteristics at, which is higher than the
23 maximum operating speed of the airplane, that you have
24 to be able to generate a peak roll rate that's
25 considered necessary for safety.

1 Q Okay, but is rudder used at all during the
2 demonstrations of that?

3 A Rudder would be used in the case of a
4 crosswind takeoff and landing to maintain the side slip
5 necessary, but only enough to maintain the side slip
6 and make sure that you can correct for any gust upsets
7 in the roll axis with the ailerons. We don't -- we
8 don't have any requirements for use of rudder as a
9 primary roll control.

10 Q Okay, thank you. And then, so then would
11 rudder be used for roll control at any point during
12 certification testing? I guess from your last answer
13 the answer is no, but --

14 A Right, as I said, the only time it comes in
15 is actually as a consequence of going out to full
16 rudder on airplanes that have more control power
17 available to the rudder than they do the ailerons to
18 counter it. And that's just to make sure that if the
19 pilot were to either inadvertently or otherwise, go all
20 the way out to full rudder, that we don't have bad
21 characteristics, such as rudder force reversals and
22 such.

23 Q Okay, thank you, and the final question, also
24 dealing with rudder --

25 WITNESS THIEL: Mr. O'Callaghan, just to add

1 -- just to make sure we cover -- covers enough base.
2 We do do a test that involves using rudders to excite
3 the Dutch roll. I know Airbus doesn't do that, they do
4 the Dutch roll demonstration with steady heading side
5 slips. I typically would always do them with a rudder
6 doublet. With a rudder doublet, you're using the
7 rudder pedals to -- you're trying to cycle the airplane
8 to get its natural frequency so it starts to respond,
9 and when you've got the motion basically the same plus
10 and minus, you would then release the controls, or fix
11 the controls, depending on what you're doing, and then
12 count the number of overshoots. So that would be a
13 case where you actually do use the rudder pedals to
14 induce roll. If that's what you --

15 MR. O'CALLAGHAN: Thank you for that piece of
16 information. So I guess to induce roll -- but how
17 about for a roll control itself, to achieve a desired
18 bank angles and such -- okay, thanks.

19 BY MR. O'CALLAGHAN:

20 Q Again, the final question would deal with
21 25.147, and I'll just refer you to the Exhibit because
22 it's not on the PowerPoint, that part of it, but 147 is
23 page 23 of Exhibit 7-E, and the question is -- deals
24 with demonstrating sudden changes of heading up to 15
25 degrees between certain speeds, and if you could just

1 explain what the speeds are and how the demonstration
2 is accomplished, please.

3 A Generally -- the controllability requirements
4 are generally conducted at a fairly low air speed,
5 because that's where the control power would be the
6 lowest. You don't get -- if you're at very low Q or
7 dynamic pressure, you don't have as much control power.

8 So most of these controllability requirements are
9 conducted at a speed of 40 percent above stall speed,
10 and that's the speed referred to in this specific
11 requirement. So you'd show it at 1.4 VS, and you
12 simply, with an engine inoperative, in a critical
13 configuration, critical weight, have to show that while
14 holding the wings approximately level with the
15 ailerons, that you can make sudden heading changes of
16 up to 15 degrees.

17 MR. O'CALLAGHAN: Okay, thank you. Thank you
18 all, and that concludes my questioning. Thank you,
19 Madam Chairman.

20 CHAIRMAN CARMODY: Thank you, I believe Mr.
21 Magladry was going to question.

22 MR. MAGLADRY: I have no questions.

23 CHAIRMAN CARMODY: No questions. Anything
24 else from the technical panel. Mr. Clark.

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QUESTIONING OF MR. STIMSON

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BY MR. CLARK:

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Q I heard a comment earlier, when this started that part of the stability and control evaluation is to protect the airplane from going over limit load. I think in this case we can see that rudder reversals can certainly get us past limit load. Why isn't that considered in part of this certification requirement?

A Basically, the Part 25 and particularly the flying qualities part of it, civilian control, reflects the normal operational use of the airplane, plus some margin. So for instance, for the rudder control, although the rudder control -- we usually look at steady heading side slips out to the normal use of the rudder, and we also demonstrate usage of the rudder in VMC demonstrations for engine controllability, we also show that the airplane is safe from a flying quality standpoint to a full application of the rudder.

That's different than the other axes, for instance, pitch axis, we don't show that you can do a full pull back on the stick and not damage the airplane. But in that axis, for example, feel (or FIO) might be added to it to give the pilot some indication that he's not -- that he's approaching the area where he should tread

1 lightly.

2 Q That's in the pitch mode?

3 A That's in the pitch mode. As I said,
4 basically it reflects the standard operation of the
5 airplane. For example, we don't have requirements to
6 cover spinning. We don't have any aerobatic
7 requirements in there, and the cyclic motion on the
8 rudder is not considered a normal piloting maneuver.

9 QUESTIONING OF MR. THIEL

10 BY MR. CLARK:

11 Q There was a comment that -- or we were
12 talking about PIO -- what is the -- is there a primary
13 cause of PIO -- was stability and control problems or
14 instability and control?

15 A Well, there's some of the most classic are
16 typically flying quality problems, or they're flight
17 control problems, especially in the digital systems.
18 We've actually had them in the systems that weren't
19 digital, but because a digital system is so complex,
20 and there's so many different routes that can couple
21 into motion, that's where we start really having
22 problem trying to 1) predict them, and 2) find them.

23 Q What's the -- given that it's a digital
24 system, what is it about a digital system that gets you
25 into a PIO mode?

1 A Well, again, it's the -- remember what gets
2 you into a PIO is a pilot putting an input into a
3 control system and getting unexpected motion. So he
4 does one thing and what happens is something else, and
5 he responds to that in a motion to the other direction,
6 and, depending upon the air speed, that can be
7 catastrophic, which we sometimes call a flying
8 qualities cliff, and the airplane will actually --
9 well, you can destroy the airplane. That happened at
10 Gripen twice.

11 Q What about the time delays in responses to
12 flight control inputs?

13 A The digital time delays are -- turn out to be
14 a factor that actually we stumbled into again, we
15 didn't really realize at first that if the time delays
16 were such, there would be a big problem. But with some
17 research and some problems, we decided -- we did a lot
18 of research to find out that those digital time delays
19 have got to down around a tenth of a second. If
20 they're bigger than that, what happens is you get a
21 lag. If your time delay is very big, you get a lag in
22 the control -- from the control input to the motion of
23 the airplane, so the bigger that is, the pilot doesn't
24 know what the airplane's doing. He's giving it input
25 but it's not responding the way he likes it.

1 Q And then what happens? He gives it more?
2 Holds?

3 A Basically maybe the worst case of course is
4 he pulls this much, expects the nose to go this much,
5 and it goes that much. Which thinks he's going to lose
6 the thing. So when he sees that -- initially he would
7 be very quick to react to that, probably would make the
8 next motion down to try to stop it. That would
9 probably be three times as big as it should be, and now
10 you've got the same problem going the other way. So
11 the only way he can get out of that is to let go of the
12 controls.

13 Q But do we have a positive or a fast response
14 with rudder pedal inputs?

15 A We have never seen PIOs in rudder.

16 Q Well, not directly in the rudder, but if I
17 put the pedal in -- I think somebody said earlier, I
18 have to develop a side slip and then I get roll on top
19 of that, can I get a cross coupling thing that's called
20 PIO out of that?

21 A We've never seen that. That's because the
22 rudder design is very linear, typically, because that's
23 the proportionality part of it. We've not seen a PIO
24 in the rudder axis or a coupling into roll, as far as I
25 know. All the work that we do on PIO, trying to find

1 PIOs, are basically pitch & roll in other words, we
2 have pitch problems, which I described, and we have
3 lateral roll saturation. We've seen those. As far as
4 I know, we haven't seen a lateral problem. Doesn't mean
5 that -- I don't know about them -- I don't know of any.

6 MR. CLARK: Does anybody else have any
7 comments on that whole line? Everybody comfortable.
8 Okay, thanks.

9 CHAIRMAN CARMODY: Alright, thank you, Mr.
10 Clark. We'll move down to the parties, and --

11 MEMBER GOGLIA: Can I ask a question.

12 CHAIRMAN CARMODY: Sure, out of order, but
13 I'll let you do it.

14 MEMBER GOGLIA: Just one question, Guy, you
15 used the term, describing the rudder inputs back and
16 forth, and that was not familiar to me. And I didn't
17 hear it either, something that ended in cliff, I think?

18 WITNESS THIEL: Oh, I wasn't talking about
19 rudder. What happens with a PIO is that the airplane
20 diverges quickly -- with a very bad one -- that
21 actually exceeds the structural failure of the
22 airplane, actually break up in flight in about five
23 cycles. I don't know if you remember the Gripen in
24 accidents -- those are two very classic cliffs -- we
25 call them flying quality cliffs.

1 MEMBER GOGLIA: Okay, I've got you now.

2 Thank you.

3 CHAIRMAN CARMODY: Alright, the parties.

4 We'll start with Airbus, Dr. Lauber, please. Any
5 questions?

6 DR. LAUBER: Thank you, Madam Chairman, yes I
7 do have a couple of questions that I think are
8 primarily to Mr. Thiel, although the others can jump in
9 if they wish to add to it.

10 QUESTIONING OF MR. THIEL

11 BY DR. LAUBER:

12 Q Were you present for this morning's
13 presentation or testimony by Captain Young and Mr.
14 Ghoshal?

15 A Yes.

16 Q So you heard the description of the roll
17 inhibit button in the simulator and how it was used?

18 A Yes.

19 Q Do you have any opinions as a test pilot as
20 to what effect that would likely have on pilot
21 behavior?

22 A I have done upsets in a couple of different
23 simulators with a couple different airlines -- American
24 was not one of them, unfortunately. So I've seen it
25 done more than one way. I've seen the typical way that

1 I'm used to from my military training is close your
2 eyes and, you know, he puts the airplane and something,
3 and let go and away you go. When I did it in the other
4 simulator, I don't know whether they had the same kind
5 of set up or not, but what the instructor said is don't
6 do anything. In other words, it wasn't a multiple
7 scenario that I was going to do a -- teach one thing
8 and add this to the end, it was just basically, you
9 know, close your eyes almost and don't do anything, and
10 then the airplane was set in upset and they said now
11 recover.

12 Q It was used strictly as a device to enter
13 into the upset condition and then the pilot was
14 supposed to --

15 A Yes, yes.

16 Q According to Captain Young's testimony this
17 morning, the way American used it was -- at least often
18 the scenario was to take off scenario. They were told
19 they were following a 747 and they made a normal
20 takeoff and at some point in the climb out, and
21 apparently this could happen at various places, the
22 instructor would activate this roll inhibit function
23 and then the scenario would proceed from there. What
24 kind of closed loop pilot performance would the
25 introduction of this roll and inhibition function have

1 and what would the pilots take away in terms of control
2 strategy from this kind of situation?

3 A I can't comment on what they'd take away
4 exactly. I have no idea what they would take away, but
5 what I think -- if the pilot is hands flying the
6 airplane and he takes off and does his thing, cleans
7 the airplane up and now all of a sudden he gets
8 uncommanded motion, he's going to try to stop that
9 motion. And if it's a roll, he's going to use roll to
10 stop it. He's going to use roll to do something with
11 it, and he's going to probably continue, maybe all the
12 way to the limit, maybe, if it's that bad. I don't
13 know how -- I have no idea how dynamic this was.

14 Q It was apparently about a 30 degree per
15 second roll rate, and it was in effect until the roll
16 attitude reached about 50 degrees or ten seconds
17 elapsed, it depended on where the roll started from, so
18 it's fairly dynamic -- 30 degrees per second. If you
19 were a pilot in that situation where suddenly you had
20 an uncommanded roll, you said that you would counteract
21 that with available roll control. Suppose you ran to
22 the stops on the aileron, what would be the next likely
23 --

24 A You only have one thing left. You might
25 unload a little bit, to do that, but then you have no

1 choice but to try to use the rudder.

2 Q And if the roll was continuing as you were --
3 would it be likely that you could go all the way to the
4 stops on the rudder as well in the situation, if this
5 took you to extreme attitudes?

6 A Very possible. I would -- you know, when you
7 run out of ideas, you run out of ideas.

8 DR. LAUBER: Okay, thank you. Any other
9 comments from the parties? Thank you, Madam Chairman.

10 CHAIRMAN CARMODY: Thank you. Moving to
11 American, Mr. Ahearn, do you have any questions for the
12 panel?

13 MR. AHEARN: Just a few topics, Madam
14 Chairman, thank you. I'd like to address this question
15 to Mr. Jones, if I might.

16 QUESTIONING OF MR. JONES

17 BY MR. AHEARN:

18 Q Mr. Jones, I believe with your background,
19 you'd be familiar with a hinged moment limited rudder
20 system, is that correct?

21 A Yes. That's the blow-down type of system
22 that's referred to, I believe, yesterday.

23 Q We spent quite a bit of time talking about
24 that yesterday, and let me ask you a question regarding
25 that. Isn't it correct that when a -- when you're in a

1 side slip in a hinged moment limited aircraft, you
2 cannot achieve full rudder deflection in the opposite
3 to side slip, is that true?

4 A You mean to the -- well, you'll always go to
5 the blow-down limit. You'll always be able to achieve
6 that pressure limit, but the -- probably the amount of
7 rudder that you'll be able to achieve in direct degrees
8 would be slightly less than if you were flying straight
9 ahead, because you'll have your rudder turning into the
10 wind at that point.

11 Q And then because of this, wouldn't this
12 reduce the instantaneous loads and development of
13 higher side slip loads due to the multiple doublet
14 inputs? Would that not in fact reduce the loads?

15 A Well, the loads would -- you'd get some high
16 loads because you have your rudder turning into the
17 relative wind, and it would build up the loads under
18 that condition.

19 Q It indeed would, but would the effects of
20 blow-down, it would also reduce the loads on the
21 vertical stabilizer, would it not?

22 A I perhaps don't understand your question. If
23 you have a -- it sounds to me like what you're asking
24 is that if you have a full pedal input in one direction
25 and the airplane builds up side slip at that point in

1 time, then you reverse the rudder into the --
2 essentially do what we've been calling a rudder
3 doublet, that will induce a new hinge moment, which
4 will be reflected through the fin and the rudder in
5 that case, and reverse the load on it.

6 Q Okay. Let me move on to a different set of
7 questions, please. This will be to Mr. Thiel.

8 QUESTIONING OF MR. THIEL

9 BY MR. AHEARN:

10 Q Mr. Thiel, does the FAA agree with the NTSB
11 safety recommendations concerning the lack of industry
12 awareness of structural limitations and rudder control
13 characteristics of transport category aircraft,
14 basically the recommendation that came out this year?

15 A I can't speak for the FAA, because there's a
16 lot of them. I can speak for myself.

17 Q Okay.

18 A I think it's always important to put out
19 information that pilots might not be aware of.

20 Q Okay, and I'll ask you another question in
21 response to that. Would you agree, then, that it's the
22 manufacturer's duty to identify and warn of any flight
23 control system maneuvers that, if performed, could
24 jeopardize the structural integrity of that aircraft?

25 A I can't comment on duty, but I would hope

1 that they would.

2 Q Okay. Let me ask you one more question in
3 that regard, then.

4 WITNESS STIMSON: Can I add something in that
5 regard, please?

6 MR. AHEARN: Sure.

7 WITNESS STIMSON: Actually both of those, the
8 first question regarding the NTSB safety
9 recommendations. I think 01 and 02, yes, the FAA does
10 agree with the intent of those safety recommendations
11 and that's why we put out a notice and have also been
12 working with the manufacturers to make sure that that
13 information gets put into the proper operating manuals.

14 As far as the second question goes, could you
15 repeat that one again, please. I think you asked if it
16 was the duty of the manufacturer --

17 MR. AHEARN: Let me rephrase the question.
18 Would you agree that it's the manufacturer's
19 responsibility to identify and warn of any flight
20 control system maneuvers that if performed could
21 jeopardize the structural integrity of an aircraft?

22 WITNESS STIMSON: Well, see there are a
23 myriad of potential flight control maneuvers, or
24 maneuvers that are possible with flight control system
25 that could jeopardize the structural capability of the

1 airplane. The pilot could may cyclical maneuvers in
2 the longitudinal axis as well. Any kind of open loop
3 maneuver of the airplane that was not in -- in essence,
4 within the operational capabilities of the airplane
5 would have that potential. I think there are a myriad
6 number of ways that you could get yourself into
7 trouble.

8 MR. AHEARN: We specifically talked to the V_A
9 chart yesterday as it relates to maneuvers and full
10 utilization of the flight control systems at speeds
11 below V_A . Do you have a comment in that regard, Mr.
12 Stimson?

13 WITNESS STIMSON: That particular requirement
14 says that full application of the rudder and aileron
15 should be confined to speeds below that value. That's
16 all it says. And so that if you're going to make one
17 full application, which is what it says -- a full
18 application -- that's where you should confine those
19 applications to.

20 MR. AHEARN: Below maneuvering speed?

21 WITNESS STIMSON: Right.

22 MR. AHEARN: Thank you.

23 QUESTIONING OF MR. HAWORTH

24 BY MR. AHEARN:

25 Q Mr. Haworth, let me move on to some of the

1 issues associated with the vertical motion simulator
2 that I know you're familiar with. I'll give you a
3 moment to turn on your mike.

4 A Thank you.

5 Q I know you're familiar with the limitations
6 of the VMS with respect to DFDR data. Are you also
7 aware of the modifications to the DFDR data that was
8 made to make it compatible to the VMS in the testing
9 that was done?

10 A I am just a little bit aware of that. Most
11 of that was taken care of by John O'Callaghan while he
12 was at the VMS, so I just heard that in the background,
13 I guess you might say.

14 Q Okay. With your commentary earlier regarding
15 lack of VMS cues during the second vortex, I believe
16 was your statement, isn't it possible that due to the
17 DFDR sampling rates and the fact that the VMS had to be --
18 what I'll say is desensitized to reduce the feedback, could
19 that not have reduced feedback to the VMS pilots?

20 A Could you specifically restate your question,
21 please?

22 Q Sure. There were two things that were, to my
23 understanding when we went into the VMS to test it.
24 One, was the issues associated with sampling rates, and
25 they're not everything, I mean because the DFDR is like

1 taking a snapshot with a camera versus doing it with a
2 motion camera, there are limitations of the DFDR. And
3 then the other is that they had to do some
4 desensitizing of the VMS. Could that not have reduced
5 the feedback that you would have receive as one of the
6 VMS pilots, addressing your lack of VMS cues commentary?

7 A I really don't think so. I mean there is
8 probably some high frequency information that was -- as
9 introduced earlier -- that we did not have, that I'm
10 not really certain from what I could tell that if a
11 reintroduction of the high frequency information would
12 have made much of a difference. But you know, you
13 don't know that until you actually put that in an
14 experimenter, into a trial to really find that out, and
15 that's the way it should be. I do also know that of
16 course, the sampling rate on the flight data recorder
17 has different sample rates on different channels, and
18 certainly that could filter some of that high frequency
19 information.

20 Q Okay, well perhaps we'll get that in the
21 phase three of our testing.

22 FURTHER QUESTIONING OF MR. THIEL

23 BY MR. AHEARN:

24 Q When you did the simulator training for upset
25 recovery, did you find it more valuable than just the

1 pure classroom environment?

2 A Abso -- oh, obviously. The best thing to do
3 is go up and do it in an airplane, there's no doubt
4 about that, but I'm not sure there's enough money in
5 the world for everybody to do that.

6 Q I agree, sir.

7 A But as far as doing it in the simulator, it
8 has to be done extremely carefully. It should be in
9 the center of the envelope because you know, we do know
10 the limitations of simulators, and you have to be very
11 careful of what you're doing. So -- you have to
12 orchestrate what you're doing very carefully.

13 Q Agreed.

14 A So that's why I think the idea of doing it
15 the old fashioned way is put it in the heart of the
16 envelope, let the pilot close his eyes, don't give him
17 something ridiculous, just give him something -- you
18 don't need to make the airplane violent to get the
19 training across that hey, guy, you're upside down,
20 you've got to roll towards the horizon, and I think you
21 will get some additional training that you wouldn't get
22 otherwise.

23 Q Okay, thank you.

24 A Let me tell you, that's my opinion only.
25 Because the people in charge of simulator are the

1 flight standards people. That's their --

2 Q Thank you, appreciate it. And to your
3 comment about American, maybe one day we'll get you
4 into the AAMP program.

5 A Any time.

6 MR. AHEARN: Madam Chairman, that ends my
7 questioning, thank you.

8 CHAIRMAN CARMODY: Thank you. On to Allied
9 Pilots, Captain Pitts.

10 CAPTAIN PITTS: Thank you, Ma'am.

11 QUESTIONING OF MR. JONES

12 BY CAPTAIN PITTS:

13 Q Mr. Jones, could you help us sort out the
14 questions of the certification history of the aircraft.
15 Were you here to hear the previous day's testimony on
16 that/

17 A Yes, I've been here for the hearing.

18 Q Can you tell us what the certification basis
19 of this aircraft, the 605-RS?

20 A The 605-R, for the most part, the 605-R is a
21 derivative aircraft from the original A300 and the
22 genealogy is that you had the A300, B2/B4 was the
23 original, then the A310-200, the A310-300, and then the
24 A300-600. And my understanding is that Airbus had
25 stepped up to the latest certification requirements at

1 the time, for most of the requirements -- there were
2 several that weren't stepped up to, but for quite a few
3 of the latest certification requirements, they were
4 stepped up to as far as a certification basis for the
5 A300-600.

6 Q So 605-R had areas that were not stepped up
7 to, is that correct?

8 A There were two or three that were not stepped
9 up to.

10 Q Can you share which ones those were with us?

11 A I don't recall which ones they were. I know
12 with regard to -- I could speak to the general flight
13 control system requirements, that that one was stepped
14 up to, and in fact, the original A300 had a special
15 condition that was essentially the same thing, and I
16 believe that for the handling requirements, they had
17 requirements that were stepped up to -- to the latest,
18 but Don Stimson could talk to that.

19 WITNESS STIMSON: Sure, I can --

20 CAPTAIN PITTS: Yes, please do.

21 WITNESS STIMSON: For the handling qualities
22 requirements, they did step up to -- and then the 44
23 was the certification basis for most of the airplane --
24 Part 25, amendment 44, and amendment 42 was the last
25 one that added some handling qualities requirements.

1

2 BY CAPTAIN PITTS:

3 Q So the special handling, special conditions
4 that you mentioned, was that inherited with the
5 previous rudder design?

6 A The original special condition was applied to
7 the A300 B2/B4, which had the original rudder control
8 system with rudder ratio change. And incidently, I'll
9 just mention here that that same special condition had
10 been historically been applied to the various transport
11 airplanes that had been certified, probably since, I
12 think, 1968, 1970 time frame.

13 Q Okay. Considering the requirement to
14 demonstrate by test or test analysis, the handling
15 qualities, what is -- what is your opinion of the lack
16 of the test using doublets -- that technique by Airbus,
17 versus -- as it was previously discussed and testified
18 to by Captain Jacob?

19 A That's really a handling quality issue, and I
20 think that probably Mr. Thiel would be the best person
21 for answering that.

22 WITNESS THIEL: The -- I think you're
23 speaking about Dutch roll -- you're speaking about how
24 you excite the airplane to look at Dutch roll.

25 CAPTAIN PITTS: Yes, sir.

1 WITNESS THIEL: Okay, when you're doing a
2 maneuver to gather flight test data, as we've been
3 talking about, you're trying to excite a Dutch roll
4 frequency -- that's the only thing you're trying to do.
5 So whether you do it with a steady heading side slip
6 and release, which, for me, always winds being
7 unsymmetric, that's why I don't like doing it. The
8 other technique, which is used, I think, by most of the
9 people that I know, and certainly taught in the test
10 pilot school, is you start moving the rudders, just
11 very little at a time. The frequency starts very slow
12 until you say, ah, there's the natural frequency of a
13 Dutch roll, at typically -- you know, five cycles per
14 second is pretty typical. And once you get it excited
15 enough that you can gather the data, and that's -- and
16 you're probably moving -- you're probably three or four
17 degrees of side slip, maybe, and maybe ten degrees of
18 bank, you want to release your feet off the rudders and
19 you count the overshoots. So you're not trying to go
20 beyond anything other than to excite the Dutch roll.

21 CAPTAIN PITTS: Alright, sir. Mr. Haworth.

22 WITNESS HAWORTH: Yes.

23 MR. CLARK: One quick question. You
24 commented the Dutch roll is about five cycles per
25 second, is that -- or five seconds per cycle?

1 WITNESS STIMSON: Point two hertz.

2 WITNESS THIEL: Yes, thanks, sorry.

3 QUESTIONING OF MR. HAWORTH

4 BY CAPTAIN PITTS:

5 Q That's it? Mr. Haworth, in Part 25.143,
6 there's a discussion of airplane/pilot coupling. Are
7 you familiar with that?

8 A I'm familiar with the 143, but Don Stimson
9 probably would be the most familiar with it since he's
10 a specialist in that area.

11 Q Okay, I'm not going to ask a question about
12 the regulation itself, but I'll give him a chance,
13 certainly to comment. I'm most interested in where it
14 speaks to -- it states that "artificial trim and feel
15 systems, which produce controllers with too small a
16 displacement and light force gradients may also lead to
17 severe over control". As a human performance expert,
18 in your opinion, does the A300-605-R rudder system have
19 a too small displacement and light force gradient which
20 may be falling prey to this very warning?

21 A I have to tell you, it's situational, and I
22 have not flown the aircraft before, and I'd have to
23 defer that to the test pilots.

24 Q Do you know of an aircraft that has a lower
25 break-out force on the rudders?

1 A I have to tell you I'm not familiar with all
2 the aircraft in terms of break-out forces to make that
3 conclusion for you.

4 Q Alright, sir, and then in terms of human
5 performance studies, you're not aware of any studies
6 which speak to maybe a minimum value that might want to
7 be considered in terms of human/machine interface?

8 A I can't think of any that I could cite at
9 this particular time, no.

10 CAPTAIN PITTS: Alright, sir. Mr. Stimson,
11 did you have something you wanted to add to that?

12 WITNESS STIMSON: No, I guess maybe to
13 clarify that actually in the requirement 25.143 does
14 not refer to APC directly. It's a general
15 controllability, maneuverability requirement and I
16 think you're quoting from the guidance material that we
17 use as a means of compliance, but you are correct in
18 citing that requirement as being the one that drives
19 the evaluation of APC tendencies.

20 CAPTAIN PITTS: Thank you for clarifying
21 that. Mr. Stimson, what is the definition, or what
22 does the term fail-safe concept mean? In terms of the
23 regulations?

24 WITNESS STIMSON: I think you're getting more
25 into the systems safety aspects and structural aspects

1 that we don't deal with the fail safe concept,
2 typically, in handling qualities.

3 WITNESS JONES: Yes, I'd just mention that
4 fail safe is, at least from my point of view, although
5 I always am looking for other definitions, but it
6 basically is the notion you can have a failure and the
7 system is still safely flyable. And the requirement of
8 25.671 requires that no single failure in a control
9 system should result in catastrophe, and that
10 combinations of failures that could must be extremely
11 improbable, which tends to drive towards redundant
12 systems, that if one channel fails, that continued safe
13 flight and landing is possible after that failure.

14 CAPTAIN PITTS: Were you here to hear the
15 testimony on the rudder system design from yesterday?

16 WITNESS JONES: Yes.

17 CAPTAIN PITTS: Would you consider the RTL
18 system to have an adequate redundancy and meet design
19 to a fail safe concept?

20 WITNESS JONES: It is designed to a fail safe
21 concept, in my opinion.

22 CAPTAIN PITTS: And what would the system use
23 as a level of redundancy in the event of the jammed or
24 stalled electrical motor discussion that we had
25 previous during that system's discussion?

1 WITNESS JONES: I'm thinking that you're
2 referring to the fact -- are you referring to where the
3 pilot application of pedal force would stall out the
4 RTL?

5 CAPTAIN PITTS: That's correct.

6 WITNESS JONES: Actuator? I don't know that
7 I would call that particularly a failure. I do know
8 that if they hold and maintain the actuator in a
9 stalled condition like that by pilot application of
10 force, that there will be an alert. The system will
11 provide an alert in the form of an oral warning, which
12 would then provide a direction to the pilot of
13 something that he should do. For that to be a real
14 problem, I think you would have to stall that actuator
15 at a low speed and then speed up to a very high speed
16 and just stall the actuator at that point, and maintain
17 pedal.

18 CAPTAIN PITTS: Then other systems that use -
19 - or other aircraft that have used this system with
20 other features, such as blow down, you think that's a
21 triple redundancy then -- another redundancy layer that
22 may not be necessary?

23 WITNESS JONES: In blow down systems? in
24 systems that use --

25 CAPTAIN PITTS: Yes, sir. Other systems

1 using this methodology of limiting the rudder travel
2 limit.

3 WITNESS JONES: I'm just -- a system -- now
4 some of the systems that I heard discussed yesterday
5 had also mentioned about -- I think they called it flow
6 limiting, which I think was probably the same thing as
7 using pressure reducers, which -- you could have the
8 effect of a pressure reducer failure which could then
9 allow you to have more authority under those types of
10 conditions, and -- but for just a direct blow down
11 system that doesn't use pressure reductions part of it,
12 I don't see how you're going to get more authority than
13 the blow down limit with that type of system. I don't
14 see a parallel failure.

15 CAPTAIN PITTS: Thank you. I have no further
16 questions.

17 CHAIRMAN CARMODY: Thank you. And finally to
18 the FAA, Mr. Donner.

19 MR. DONNER: Thank you, ma'am. Only one
20 question, and I believe it was Mr. Jones who was
21 talking about the cert basis for the aircraft, and
22 mentioned that Airbus had stepped up to a particular
23 amendment. Could you say a few more words about what
24 you meant by stepped up to?

25 WITNESS JONES: It's my understanding that

1 the original cert basis of the -- I don't recall, I
2 think it was the original cert basis for the A300 --
3 was to -- was the FARs as amended through amendment
4 number 19. At the time of the certification of the
5 A300-600, I believe that Airbus voluntarily stepped up,
6 or chose to show certification to a higher level of
7 requirements up through, as Mr. Stimson had mentioned,
8 up through amendment level 44. And the particular
9 requirement that I mentioned, 25.671 -- they
10 voluntarily stepped up to that one, and that was
11 through amendment level 23. It hadn't been changed
12 since amendment level 23.

13 MR. DONNER: Thank you. I just wanted to
14 make sure that was clear. Thank you very much.

15 CHAIRMAN CARMODY: Was that all, Mr. Donner?

16 MR. DONNER: Yes, ma'am. That's all, thank
17 you.

18 CHAIRMAN CARMODY: Very good. Thank you. Up
19 to the Board. I see nothing from Mr. Hammerschmidt.
20 Member Goglia?

21 MEMBER GOGLIA: No questions.

22 CHAIRMAN CARMODY: Member Black.

23 MEMBER BLACK: Yes, ma'am. Just one to was
24 it Captain or Colonel Thiel -- or whatever you go by
25 now. A question, I think you mentioned you had gone

1 through some sort of an unusual attitudes training at
2 one airline -- you don't need to mention which one --

3 WITNESS THIEL: Actually two.

4 MEMBER BLACK: Two?

5 WITNESS THIEL: Yes.

6 MEMBER BLACK: Have you been here to hear a
7 description of the AAMP of American?

8 WITNESS THIEL: I've been here listening to
9 the discussions the last two days.

10 MEMBER BLACK: Would you describe the others
11 as being similar, equal to, more than in aggressiveness
12 or could you characterize?

13 WITNESS THIEL: That would be difficult -- it
14 would be hard for me to compare when I've never seen
15 what they do. I can only describe what they did to me,
16 or what I was involved in.

17 MEMBER BLACK: Did it hurt?

18 WITNESS THIEL: Sometimes it does. As I
19 mentioned to you, one of them was heart of the
20 envelope, put your hands in your lap and close your
21 eyes, and basically they gave me a nose high and a nose
22 low. And that was all there was to that type of
23 maneuver.

24 In the other airline, they actually -- this
25 was kind of aggressive, too, I have to admit. We're at

1 about 2500 feet and they induced a roll to about 120
2 degrees of bank and said recover -- with no warning. I
3 thought that was a little aggressive, and I made that
4 comment to them.

5 MEMBER BLACK: Thank you sir. I yield my
6 time to Mr. Clark. Oh, you're finished now. He had
7 sent me an e-mail that he had wanted to ask a question.

8 CHAIRMAN CARMODY: And nothing Mr. Clark?
9 Nothing further --

10 MEMBER GOGLIA: Mr. Thiel, did you recover?

11 WITNESS THIEL: Yes, I did, and the airplane
12 -- the simulator didn't crash.

13 CHAIRMAN CARMODY: Is there anything from any
14 of the parties? Any additional questions from FAA,
15 Airbus, Allied Pilots, American? Alright. I propose
16 then that we thank the witnesses and recess for about
17 15 minutes. I'd like to start on the next panel. We
18 may not finish with them, but I would like to start and
19 perhaps we can do the technical panel portion of the
20 next two witnesses.

21 Thank you very much, gentlemen, for your
22 testimony and your time.

23 (The witnesses were excused.)

24 (Whereupon, a 25 minute recess off the record
25 was taken.)

1 CHAIRMAN CARMODY: Ms. Ward, would you call
2 the next witnesses, please.

3 MS. WARD: Yes, I'd like to go ahead and call
4 Mr. John Howford and Mr. Henry Offerman II.
5 Whereupon,

6 JOHN HOWFORD and HENRY OFFERMAN II
7 were called as witnesses, and first having been duly
8 sworn, were examined and testified as follows:

9 MS. WARD: Mr. Howford, could you please
10 state your full name, your current employer and your
11 present business address?

12 WITNESS HOWFORD: My name is John Howford. I
13 am presently employed by the FAA as Chief Scientific
14 and Technical Advisor for loads and aeroelasticity.
15 The business address is 3960 Paramount Boulevard,
16 Lakewood, California 90712.

17 MS. WARD: And how long have you been in that
18 position?

19 WITNESS HOWFORD: Almost four weeks.

20 MS. WARD: Very briefly, then, what are your
21 duties and responsibilities and any kind of education
22 and training that you received to qualify you for your
23 new position?

24 WITNESS HOWFORD: I'm employed primarily
25 because of my experience and knowledge working in

1 industry as a loads analyst -- that's been my entire
2 career. And my role is to advise and consult with the
3 aircraft certification department, primarily, and to
4 assist the FAA in maintaining knowledge of the latest
5 standards, disseminating those latest standards to
6 people in the FAA and in the industry at large,
7 training functions, and to promote any research that
8 would benefit aircraft loads analysis.

9 My education -- I have a BSc from South
10 Hampton University in England, aeronautical
11 engineering. I did some post graduate studies at the
12 Canfield College of Aeronautics, also in
13 England. I took an MSc in aerodynamics. After that I
14 worked for a period of about seven years at the British
15 Aerospace Military Aircraft Division on combat jet
16 aircraft, doing loads analysis work, and that was
17 mostly mil spec type criteria for military airplanes.

18 In 1979 I moved to Douglas Aircraft Company
19 in Long Beach, California, and I was with them for 13
20 or 14 years. I worked on the whole range of different
21 aircraft, but mainly I guess, DC-9 and its derivatives,
22 DC-10 and its derivatives. I did quite a lot of work
23 on loads methods development. I left Douglas in '93
24 and then I worked for two other smaller companies since
25 that time. I worked for a period of five years in

1 Indonesia, the Indonesian Aircraft Company on a 50-C
2 twinprop aircraft, and most recently I have been in San
3 Antonio, Texas working on a Part 23 airplane, six
4 passenger biz jet.

5 MS. WARD: Thank you, Mr. Howford.

6 Mr. Offerman, can you please state your full
7 name, your present employer, and your business address?

8 WITNESS OFFERMAN: I am Henry Offerman II --

9 CHAIRMAN CARMODY: Mr. Offerman, would you
10 pull that -- Yes, good, thank you.

11 WITNESS OFFERMAN: Henry Offerman II,
12 generally Hank I'm more comfortable with. I presently
13 work for the FAA in the Transport Aircraft Directorate,
14 1601 Linda Avenue, Southwest, Renton, Washington.

15 CHAIRMAN CARMODY: I'm sorry, we can't hear
16 you. Could you pull that a little closer to you,
17 please?

18 WITNESS OFFERMAN: Certainly.

19 CHAIRMAN CARMODY: Thank you. Is it on? Is
20 the button --

21 WITNESS OFFERMAN: Yes, the button is up.
22 The name is Henry Offerman, Hank. I work for the FAA
23 in the Transport Aircraft Directorate, Standards staff,
24 1601 Linda Avenue, Renton, Washington. And I'm an
25 airframe engineer -- aerospace engineer, airframe

1 specialist.

2 MS. WARD: And how long have you been an
3 aerospace engineer for the FAA?

4 WITNESS OFFERMAN: A little over five years
5 now.

6 MS. WARD: And what are your current
7 responsibilities and duties and what is the education
8 and training that you received for your present job?

9 WITNESS OFFERMAN: My current
10 responsibilities and duties is responsibility for an
11 area of Part 25 in loads and dynamics, the rules
12 associated with it, and working in the ARAC groups that
13 handle those load sections, regulatory sections. I
14 also provide standardization and provide for -- yes,
15 standardization throughout the ACOs in the United
16 States, and with foreign regulatory agencies. I assist
17 in the certification of foreign aircraft and provide
18 advisory material and guidance to the various ACOs,
19 through either ACs or correspondence.

20 My background that put me in this -- 1962, a
21 degree in mechanical engineering from the Newark
22 College of Engineering, Newark, New Jersey, which is
23 now part of the New Jersey Institute of Technology.
24 Master's program at Georgia Tech in the mid 70's, I got
25 a Master's in aeronautical engineering and aerodynamics
from Wichita State University in the 1970's.

1 I started my career at vertol Aircraft,
2 now Boeing Helicopters, working in cockpit and flight
3 station design. Transferred to Lockheed Georgia
4 Company, working in cockpit design initially, then in
5 structural analysis in structural test, flight test
6 support. Beech Aircraft Corporation where I worked as
7 a group engineer in the structural analysis area,
8 eventually transitioning in to found the aerodynamics
9 loads group at Beech Aircraft Corporation. Moving on
10 to Martin Marietta where I was the manager of the
11 mechanical engineering department for their commercial
12 aircraft division in Baltimore, Maryland. Was a
13 subcontract designer in manufacture for Boeing, Airbus,
14 McDonnell Douglas, and a variety of other companies.
15 Left that to go to work for Hiller where I was vice
16 president of engineering, a helicopter company, and
17 after that had my own company which was engaged in
18 aircraft modification and certification. Sold my part
19 of that company, came to the FAA. During the period of
20 time from the 1980s on up I was a consulting BER for
21 the FAA for Part 23, 25, 27, and 29 aircraft in the
22 structural field.

23 MS. WARD: Do you currently have any FAA
24 aviation certificates, flight time, or -- and what type
25 of aircraft have you flown?

1 WITNESS OFFERMAN: Private pilot, single
2 engine land, inactive.

3 MS. WARD: Thank you, Mr. Offerman.

4 Madam Chairman, I find these witnesses
5 qualified, and now pass over to Mr. Brian Murphy for
6 questioning.

7 CHAIRMAN CARMODY: Please go ahead.

8 MR. MURPHY: Good evening, gentlemen. I'd
9 like to discuss just the following topics with you
10 today. The lateral load requirements in place at the
11 time of the certification of the Dash 600-R. The FAA's
12 actions since the accident from a load perspective
13 only, and the FAA's role in foreign certification
14 programs from a load and structures perspective. Mr.
15 Goldberg, if you'd go to Exhibit 7-F, page two, please.

16 Also the text of this regulation is contained in the
17 actual document, Exhibit 7-E, page 31. This Airbus
18 Exhibit is much, is easier to -- oh, I'm sorry -- the
19 text is contained in that, this illustration helps to
20 explain that.

21 QUESTIONING OF MR. HOWFORD

22 BY MR. MURPHY:

23 Q Gentlemen, would you please describe the
24 yawing maneuver requirements.

25 A Do you think we could start with the next

1 slide, please, page number three?

2 Q That would be fine.

3 A FAR 25.351 subparagraph (a) is the maneuver
4 part of the yawing design conditions. This is a
5 maneuver that is particularly called the rudder kick
6 maneuver. It's a rational maneuver, in total, the
7 regulation defines a single maneuver from which --
8 within which there are embedded a few points which are
9 of special interest to loads. The regulation details
10 what those conditions are. But this is just in total a
11 rational commission. It's one that you can go and fly
12 in airplane. It's a wings level condition. It's not
13 coupled with any roll, although when you do the
14 maneuver, there will be some lateral motion of the
15 airplane.

16 So if you take a look at the picture, what
17 you see is that from straight and level flight, the
18 pilot is basically assumed to rapidly, suddenly, input
19 full rudder control up to a maximum of 300 pounds at
20 any speed between VMC, minimum control speed, and VA,
21 the design maneuver speed, and hold that. In response,
22 the airplane suddenly slips and rolls somewhat
23 sideways. The rolling motion is controlled by the
24 ailerons, so as the rudder is held, the side slip is
25 going to build dynamically to a peak value, before

1 eventually settling down to a final steady state side
2 slip value. That peak value -- unfortunately this
3 picture is schematic only, it's not particularly well
4 done to scale -- the peak side slip value would
5 typically be something like 1.5 or 1.6 times the steady
6 state value, and so we have a number of points to
7 consider.

8 The first one is the point where the rudder
9 first reaches its initial maximum deflection. At that
10 time the airplane is still basically flying straight
11 ahead and hasn't had time to yaw yet, but we have a
12 large initial rudder displacement. Subsequently, as
13 the side slip develops in response to that rudder
14 input, the side slip hits a peak value, which we often
15 call the dynamic overswing side slip value. That is
16 the second point we will look at.

17 Subsequently the airplane settles into a
18 steady wings-level yaw, that becomes the third point.
19 Then from that point we rapidly, suddenly return the
20 rudder to neutral position, and that becomes the fourth
21 point. So that's the description of the maneuver.

22 Q Thank you. A couple questions with regard to
23 that. Now, I won't go into the requirement for
24 doing a doublet because I think we've beat that to
25 death today. One thing I would like, though, is could

1 you illustrate on there where Beta-max would be. You
2 described it -- is that point B, then? Maximum side
3 slip?

4 A It's here.

5 Q Okay, so that would be max side slip, and
6 then -- Where are you? I believe it's point B, the
7 peak on the graph, yes. Now the only question I have
8 regarding that was that the regulations currently do
9 not require the return of the rudder at max Beta, max
10 side slip. Could you address that?

11 A That's correct.

12 Q Could you address possibly why that
13 consideration is not taken, and what would be the
14 effect if it were on the loads on the vertical
15 stabilizer?

16 A If the rudder were to be reversed from steady
17 side slip or from maximum side slip?

18 Q From maximum side slip.

19 A Okay, if we were to return the rudder to
20 neutral position from maximum side slip, we would see,
21 probably an increase in one of the components of fin
22 load, probably that would be the bending load on the
23 fin. We may or may not see some changes in some of the
24 other load components. The rudder kick is of interest
25 for bending on the fin and for torsion. It may well be

1 that there would be no increase in torsion, but there
2 would almost certainly be an increase in the bending on
3 the vertical ...

4 QUESTIONING OF MR. OFFERMAN

5 BY MR. MURPHY:

6 Q Now, I understand that you're not a pilot,
7 the reason for not requiring this, you're speaking from
8 a loads point of view -- would the reason for not
9 requiring this be as stated with the doublet, it's not
10 considered rational?

11 A I think in addressing that one should
12 recognize that Part 25 in the main, defines an envelope
13 of design conditions that define the strength of the
14 airplane under various conditions. While the loads
15 development is rational, the rational is a great sense
16 due to historic evidence and historic -- the history of
17 the uses of the airplane. Part 25 is a transport
18 category airplanes -- Part 25 airplanes are meant to be
19 an airplane for the transportation of passengers, large
20 numbers of people and are heavy airplanes. And
21 historically, in developing the loads envelope, these
22 maneuver conditions for the maneuvering portion of the
23 design of the vertical fin was described in this form
24 with the implementation of CAR 4B about 1953. Since
25 1953 there has not been any historical evidence that

1 would lead us to believe that this, as an envelope and
2 design requirement was inadequate.

3 Q I said I was going to stay away from it, but
4 Mr. Offerman, what would be the effect then of -- when
5 we were at Beta steady state, if we did do the doublet
6 that we've been discussing today?

7 A That is an extreme maneuver. One of the
8 things to recognize is the result in returning the
9 rudder to -- or reversing the rudder at point C, is
10 that the position you're talking about?

11 Q Once we've established a stead side slip,
12 instead of just going to neutral, pass through neutral
13 to the opposite.

14 A If you were to reverse the rudder at point C,
15 you would first have a load build up, that is in excess
16 of the point C load requirement right now. It'd be a
17 bit higher, but more importantly, if you actually
18 performed a reversal and then allowed the airplane to
19 go out to the other side and then reversed it again,
20 you would start a series of dynamic maneuvers which
21 could be either benign or could lead the airplane into
22 a severe dynamic situation where, at the proper
23 frequency, this continued application of this surface
24 would allow the motion of the airplane to build up to
25 the point where the side slip would become excessive

1 and overload the airplane.

2 Q Thank you. Mr. Goldberg, if we could go to
3 Exhibit 7-M. I think we're going to start on page
4 four. It should be a graph. I believe for everyone
5 else, it's page five in the Exhibit packages, but
6 that's the proper page. Now the text of this
7 regulation as well is contained in 7-E, page 32 in the
8 top left hand corner.

9 FURTHER QUESTIONING OF MR. HOWFORD

10 BY MR. MURPHY:

11 Q Gentlemen, would you please describe for me
12 the gust criteria that was in place at the time of the
13 certification of the Dash 600-R?

14 A Yes, that's subparagraph (b) in the same
15 regulation, 25.351 at that time. That defines a
16 discrete gust event. Again, it's a rational event.
17 It's not a instantaneous condition, it takes a certain
18 time. It involves the airplane traversing a gust which
19 is a bump of the shape that you see on that picture --
20 a harmonic one minus cosine shape -- and the gust
21 velocity builds from zero initially to a maximum in the
22 time it takes an airplane to travel a distance equal to
23 12 and a half cord lengths of the wing. Thereafter it
24 decreases back to zero again in a further 12 and a
25 half. So we call this -- we actually call this a 25

1 cord length gust.

2 The design intensity, the peak gust value, is
3 also specified in criteria at one of three different
4 speeds that we have to look at. We have to look at VC,
5 the design cruise speed, which is the nominal case. We
6 also look at VB which is design gust speed, which is a
7 lower speed but we assume a higher gust velocity. And
8 we also look at the case of operating a V-dive which is
9 outside the normal operating envelope with a reduced
10 gust velocity.

11 Q If you can move two pages forward in that
12 please? Could you just, Mr. Howford, possibly describe
13 or discuss the means of compliance that's described
14 here, the possible models that would be used to comply
15 with this regulation?

16 A Yes. The applicant has a variety of options,
17 ways to show compliance with the discrete gust
18 requirement. The two that are listed here are discrete
19 gust quasi flexible, which is on an Airbus sheet here,
20 is what I would call static air elastic effects. The
21 second one is discrete gust full flexible, which is
22 including dynamic elastic effects. There is a third
23 way, not mentioned here, which is to use a simple
24 formula called the Pratt formula, and I think that's
25 discussed earlier in this sheet.

1 Both of the methods that are shown here
2 include flexibility of the structure, so that the loads
3 that the airplane encounters during the gust include
4 the deformation of the structure. But in the first
5 case, in the quasi flexible case, the deflection that
6 they mean there is the quasi-static deflection, no
7 vibration of the structure, just the steady deformation
8 of the structure as it loads up, and then relaxation of
9 the structural deflection as the load comes off again.

10 That deformation of the surface has the effect of
11 changing the aerodynamic profile, and therefore
12 changing the aerodynamic loads. In general, those
13 effects are relieving, so they will relieve the load.

14 The second one, the discrete gust fully
15 flexible is something different again. It's a very
16 much more complicated analysis where we involve not
17 only the flight dynamics of the airplane as it flies
18 through the gust, but also the structural dynamics of
19 the vibration of the structure. And the structure,
20 being an elastic structure, composed of mass and
21 stiffness elements, will vibrate and it's relatively
22 easy to determine a set of modes, shapes, which are the
23 characteristic deformation profiles, which the airplane
24 will vibrate and if it's excited at sufficiently fast a
25 frequency. And when we do the fully flexible analysis,

1 we would be exposing the airplane to exiting those
2 structural modes -- the gust itself is a very quick
3 event. It's -- the distance taken to travel 25 cord
4 lengths is very short -- so there is an opportunity
5 there, a very quick loading, almost an impulsive
6 loading, and that will excite structural vibration.
7 That brings with it incremental aerodynamic loads on
8 steady effects, and of course inertia loads as the
9 structure vibrates backwards and forwards, the mass
10 accelerations have incremental inertial loads too.

11 Now, the discrete gust fully flexible, at the
12 time of certification of the A600 was not an FAR
13 requirement. Only the discrete gust, either rigid or
14 quasi flexible was a requirement.

15 FURTHER QUESTIONING OF MR. OFFERMAN

16 BY MR. MURPHY:

17 Q Now that we have the baseline definitions out
18 and understood, could we move on to the Exhibit 7-I,
19 pages four and five, the actual certification
20 documentation contained in Exhibit 7-E, page 46.
21 Before I begin the discussion on these, could you tell
22 us what the complementary condition is? Why they would
23 be required or why they would be put in place?

24 A Certainly, the regulations were formulated
25 based on airplanes that were, as they were understood

1 and envisioned at the time the regulations came into
2 place. From the time the regulations originated until
3 the time of the A300-600 came along, airplanes changed
4 significantly and in the area of controls and control
5 systems, the airplanes went from manual controls -- the
6 old DC-3, DC-6, DC-7 wrestling matches -- to power
7 controls systems.

8 A little bit of a history. The requirement
9 for the deflection of the control surfaces, that VA,
10 was built around the airplanes with mechanical control
11 systems where the pilot put his input in, could detect
12 directly the force build up as the surface was
13 deflected, and had a direct control over the surface,
14 either through the surface itself or through
15 aerodynamic servos that did this task for him. And the
16 requirement that existed at the time was to simply --
17 not simply, but to design the surface for deflections
18 to the maximum limits of the stops, or the maximum
19 pilot effort, which for the rudder pedals is 300
20 pounds, from VMC to VA. There was no explicit
21 requirement to design above VA and it was understood
22 that the pilot recognized that as speed built up, he
23 would apply the controls a bit more gingerly.

24 When you went to powered systems, the
25 hydraulic actuator doesn't know this any more. The

1 hydraulic actuator will put out the force that it's
2 designed to put out and typically speaking, the
3 feedback systems are positional as limited by the
4 maximum hinge moment of the actuator such as in a blow
5 down system. So there had to be something to be done
6 above VA for these powered systems. And the
7 complementary condition was a requirement imposed by
8 the European communities as a means of explaining an
9 appropriate way of complying with those regulations for
10 airplanes for which a literal direct compliance would
11 not be appropriate.

12 And in a position of CC5-1, we had the
13 recognition that you had a powered control system in
14 there, so they were required that the airplane be
15 designed up to VD, from VMC to VD for the maximum
16 deflection as limited by the stops, for the maximum
17 power of the servo controls -- if it was servo control
18 limited, or by the application of the 300 pound pilot
19 effort force, which for a servo system and an
20 artificial field system kind of becomes a little bit
21 superfluous. But that was the reason for CC5-1, it was
22 to expand the regulations and interpret them in a
23 manner that would be consistent with the intent of the
24 regulations but specifically for that type of an
25 airplane.

1 Q Okay, having given that definition then,
2 would you say that the addition of CC5-1 met or
3 exceeded the requirements in place at the time of the
4 certification?

5 A In a literal sense, they exceeded the
6 requirements of certification at that time. At that
7 time, because it required the use of the maximum pilot
8 effort of 300 pounds up to V-dive, or the maximum
9 travel compatible with the stops up to V-dive, which
10 was beyond what the present regulation required. It
11 was not inconsistent with the intent of the
12 regulations, which was to assure a certain strength
13 level in the controls and control systems.

14 WITNESS HOWFORD: I'd also add it exceeds the
15 current requirements also.

16 FURTHER QUESTIONING OF MR. HOWFORD

17 BY MR. MURPHY:

18 Q If we could, if we could go to Exhibit 7-I,
19 page six. This is another complementary condition.
20 This one's with regard to the gust. I believe these
21 are probably -- this complementary condition, I
22 believe, is summed up fairly well on -- I'm sorry, Mr.
23 Goldberg, if you would go to Exhibit 7-M, page four, I
24 believe these -- there are four bullets there on the
25 bottom of that page which summarize that complementary

1 condition. And gentlemen, if you could take us through
2 the -- what's the effect of adding those four bullets
3 at the bottom of page four in Exhibit 7-M?

4 A These are the two gusts that we were talking
5 about just a moment ago, the fully dynamic gust. CC6
6 is telling us that Airbus is electing not only do a
7 rigid body gust, but also do a fully flexible tune gust
8 --

9 Q Just one second. I'm sorry, Mr. Howford.
10 Mr. Goldberg, it would be 7-M as in Mary, page four.
11 Yes, and then those four bullets at the bottom. I
12 believe they're what is contained -- the summary of
13 what's contained in complementary condition number six.
14 Again, Mr. Howford, if you would tell us the effect of
15 those.

16 A Yes, they've elected to do a tuned discrete
17 gust, which means that they're not only using fully
18 flexible aircraft structural response in gust load
19 calculation, but they're also varying the gust
20 wavelength to see if they can tune the structure
21 response to a specific maximum load within a given
22 range. And what they've done is about the mean of
23 12.5, they've tuned the gust with different gust
24 wavelengths in the range of seven cord lengths to 18
25 cord lengths.

1 In addition to that, they had done something
2 somewhat -- this regulation or something very similar
3 to this regulation is now part of the current criteria
4 both here and in Europe. But at the time, it wasn't,
5 so there had been talk about this at the time, and
6 Airbus elected to go ahead and do that. On an earlier
7 model, they had done that on the A300 -- A310-300, I
8 believe -- they had done this same method, but they
9 elected to use 90 percent of the design gust velocity.

10 When they came to the A300-600, they reverted back to
11 full design gust velocity, tune gust dynamic response.

12 In addition, the last bullet -- the last of
13 those four bullets says that they are also going to
14 study an additional gust load criteria, which is the
15 loads in flight through continuous turbulence.

16 Q And then again, this would be in exceedence
17 of what was in place at the time, and more closely
18 resembles what is required of today.

19 A Indeed.

20 WITNESS OFFERMAN: I think I would like to
21 mention that for US certification, the aircraft
22 requirement to evaluate the gust loads continuous
23 turbulence was a requirement, not a study.

24 BY MR. MURPHY:

25 Q Okay. We don't need to go to the next

1 Exhibit, but have you had a chance to review the
2 material in 7-K on pages three and four? It's the
3 loads methods that were applied -- that are used at
4 Airbus for calculating their loads? It's two slides
5 there, basically summarizing loads programs, loads
6 methods?

7 A Yes, Mr. Murphy.

8 Q Very simply, are the methods that are
9 described here for determining loads due to maneuvers
10 in gusts typical in the industry? Would this be
11 carried out in the same way at other major
12 manufacturers? Same approach, same thought process?

13 A Well, this is very much a top level job and
14 yes, it conforms very much to standard practice. This
15 is the kind of processes that would go on in defining
16 the aircraft response condition, the design conditions,
17 as we call them. Having developed those, using
18 processes like this, you would then go on to a separate
19 process where you obtain the distributed loads on the
20 components you're interested in, e.g., vertical tail.
21 But yes, this is very -- this is pretty standard
22 methodology.

23 What it's showing is that -- I guess on the
24 top line they're showing methods -- static methods,
25 dynamic methods and statistical methods. On the

1 bottom, rigid model, quasi flexible, and fully dynamic.

2 The top line, the methods, is the kind of conditions,
3 the kind of flight conditions they're looking at. The
4 static case, for instance might be a steady bank turn,
5 which doesn't vary with time. I mean, yes, you're
6 going in a bank turn but everything is staying the
7 same. Some of the other conditions can also be
8 considered static. The timed demanded (ph) dynamic
9 conditions where the flight dynamics become important
10 and you have to predict the response of the airplane so
11 that you, in the computer, develop the response much as
12 the pilot would see out the window, like a rudder kick
13 maneuver. And the statistical processes are the ones
14 like the continuous turbulence, where we have a
15 randomized statistical procedures to determine the
16 average loads during continuous flight through
17 turbulence.

18 On the bottom, the bottom line is airplane
19 methods, and this is a reflection of whether or not
20 they're including the structural dynamics in that or
21 not. And there's a full range here. They're including
22 rigid body dynamics, that is to say when the airplane
23 moves around the sky doing maneuvers but the structure
24 doesn't vibrate. This quasi flexible, which is when
25 you include the static effects of structural

1 deformation on the aerodynamic load distributions. And
2 there's the full dynamic where you consider the
3 structural vibration as well.

4 Q As well, so that full dynamic would imply
5 then the quasi flex is in there as well. It's the best
6 we're going to get.

7 A It's the best you can do.

8 WITNESS OFFERMAN: I'd like to add a little
9 to that, if I may. The regulations require that the
10 applicant compute his loads in either a rational or
11 conservative manner. And so the applicant has his own
12 -- has his choice of how he wants to conduct his
13 business, how he wants to do his engineering, as long
14 as we understand it to be rational or conservative.
15 And so any of these methods are appropriate. They all
16 have their advantages and disadvantages, depending on
17 what areas you're looking in. But in the end, when an
18 applicant selects a method to do an analysis, he then
19 has to do the whole analysis consistent with the
20 various assumptions, conditions and requirements for
21 data contained in that.

22 FURTHER QUESTIONING OF MR. OFFERMAN

23 BY MR. MURPHY:

24 Q Thank you. Mr. Goldberg, if you could go to
25 Exhibit 7-F, page four. The text of this chart is

1 contained on, again, Exhibit 7-E page 28 on the lower
2 left hand side. Mr. Offerman, if you would, could you
3 please just take us through this graph and explain to
4 us, for the days to come, the discussions to come, the
5 definition of limit load, ultimate load, operating
6 loads?

7 A Certainly. In the regulations, all loads in
8 the regulations are defined as limit load. Limit load
9 is defined in the regulations simply as being the
10 largest load expected in service. And with regard to
11 certification to FAR 25, that is the largest load that
12 is consistent with any of the design conditions that
13 come out of FAR 25. In many areas, as I indicated,
14 this becomes an extreme condition or extreme maneuver
15 for the airplane, which sets up a load envelope such
16 that we are reasonably sure that all of the loads that
17 the airplane will experience in service will fall
18 inside that envelope. That's limit load.

19 Operating loads are significantly lower than
20 that for many parts of the airplane. I dare say that
21 for maneuver load factor, a transport airplane is
22 typically two and a half Gs. You can get into
23 turbulence, to hit two Gs is kind of an extreme event.

24 The lateral load conditions -- these design conditions
25 might give you a lateral load factor of about --

1 correct me if I'm wrong -- three to four Gs. It is
2 unusual to hit a side load -- 0.3. It's unusual to hit
3 a side load factor of 0.2 Gs -- 0.3, yes, thank you --
4 of 0.2 Gs, and for a vertical tail, in particular, the
5 operational load is basically -- are the maneuverable
6 loads during take off and landing, descent and
7 occasional maneuvering which are generally rather mild.

8 For continuous operation, it's yaw damper operation or
9 whatever turbulence you encounter. We have the
10 operating loads for certain aspects are relatively low
11 compared to the limit loads.

12 Ultimate loads are the limit loads multiplied
13 by a safety factor, and that safety factor is a minimum
14 of one and a half, and one and a half is the number
15 that's consistent with the aircraft industry.

16 Q Two quick questions with regards to this.
17 How often is an aircraft expected to experience limit
18 load?

19 A As I said, the definition is the limit load
20 is the maximum load expected in service. For the
21 maneuver conditions that define the design envelope of
22 the airplane, it is fairly safe to say that the data
23 that was used to develop that envelope would yield a
24 once in a lifetime event, one in every 60,000 to
25 100,000 hours for the most part, and that, as I said,

1 this number wasn't picked in a vacuum. There's been
2 approximately 75 years of study that has gone into this
3 through NACA, NASA, the FAA, the military, the CAA
4 and other agencies that provide the data upon which
5 this envelope is based.

6 Q Then one last question, it's probably already
7 obvious, but is an aircraft ever expected to experience
8 ultimate load?

9 A An aircraft is not expected to experience
10 ultimate load in service.

11 FURTHER QUESTIONING OF MR. HOWFORD

12 BY MR. MURPHY:

13 Q Okay, thank you. And move on to the FAA
14 actions since the accident. If we could refer to
15 Exhibit 7-F, pages five and six. This describes an
16 operational loads monitoring program that was put in
17 place by the FAA. If you would, could you describe
18 this study, why it was performed and then summarize the
19 results for us?

20 A Yes, this was started almost ten years ago.
21 This is an ongoing research program that the FAA
22 instituted to try to collect data from the operational
23 fleet, to try to build up the database of what happens
24 day in, day out on the everyday fleet. So we've had --
25 we've been able to instrument certain fleets of

1 airplanes, A320s, DC-9 fleets, some others, and we're
2 basically collecting the data recorder data for an
3 analysis on the ground.

4 As a result of this, we're accumulating a
5 large bulk of data on operational statistics of
6 airplanes -- what do they see? What do they don't? In
7 particular, lateral acceleration, I think is one thing
8 that might interest you. That's an event that we're
9 able to now predict statistically, based upon thousands
10 of hours in many hundreds of airplanes, that you would
11 typically see nothing more than 0.2 G. And if you
12 extrapolate the data out to the once in a lifetime
13 event that might represent limit load, you're still
14 going to be less than 0.3 G. In other words, the
15 average airplane, during its entire lifetime should not
16 see more than about 0.3 G.

17 WITNESS OFFERMAN: I'd like to make one
18 correction to this chart also. The 727 and the Fokker
19 F27/F28 were not -- are not part of this operational
20 monitoring program. The data we have for those
21 airplanes comes from a previous program. They were
22 included in the chart by error.

23 FURTHER QUESTIONING OF MR. OFFERMAN

24 BY MR. MURPHY:

25 Q Okay. Now there was an AD put out after the

1 accident happened, it was the one that was prescribing
2 inspections based on certain levels of lateral Gs that
3 would be -- could have occurred in flight, so called
4 high load events, anomalous events. Were the results
5 of this study used to help develop that AD? That AD,
6 by the way, is contained -- I believe it's Exhibit 7-G,
7 three and four. It's long and wordy though.

8 A No, the results of the study did not go into
9 that AD. That AD was based upon data that was
10 generated by Airbus from information that they had,
11 that relates back to the specific characteristic of
12 their airplane. If I could expand just a little bit.
13 The load on a vertical tail, because it has a large
14 control surface on it, the rudder, is very much a
15 function of both rudder deflection and side slip angle.

16 The lateral load of 0.3 G is not an absolute number in
17 this case. It's an indication that you may have
18 experienced a high load event and it is worth your
19 while to look at the airplane, or at least look at the
20 data to decide what to do with the airplane.

21 Q There are -- in Exhibit 7-Q on page five and
22 six, there are several events described -- high load
23 events, several of them systems related, a thrust
24 reverser deployment and the two that are really at the
25 top of the list that don't have anything particular

1 written against them. Were these events identified as
2 a product of the AD, or were they identified during the
3 development of the AD?

4 A These events were investigated as we got into
5 the A300-600 airplane after the accident. It was the
6 identification of these events that led to the issuance
7 of that AD. When you look at it, on the surface it
8 would appear that there is a large number of events,
9 however, we do have about four events that were in the
10 range of limit load, a little bit above, and then two
11 events that we achieved loads that approached ultimate
12 loads. But the fact that these existed raised the
13 concern and because of the requirement to insure the
14 continued safety of the A300-600 fleet, or at least
15 assure ourselves and the flying public that the
16 airplane was indeed a safe airplane to continue flying,
17 we thought it prudent to issue the AD so that we would
18 have a handle on these types of events as they came up
19 and try and decide whether this was something that
20 might be a characteristic of the airplane or whether
21 these were explainable, identifiable situations that
22 could have applied to any airplane under the same
23 conditions.

24 Q Since you said that, did you think that these
25 events were explainable or identifiable to other

1 aircraft as well?

2 A Well, they certainly are all A300-600s. As
3 we went into these events and started looking at them,
4 there were four events that appeared to be -- and this
5 might be a question for a systems expert -- but as part
6 of the decision process -- there were four events that
7 appeared to be events that were generated by system
8 failures where the airplane behaved, I suppose, as
9 expected. The loads were high, but they weren't
10 exorbitant. The airplane recovered and the pilots
11 recovered from that, made the appropriate configuration
12 changes, whatever, pressed on and finished the flight.

13 The other two events were rather high loads.

14 Both of those events were associated with departures
15 and high a high pilot activity or pilot component to
16 them. And indeed, if you look through the events, they
17 were rather long in duration, probably one minute for
18 both of these. By the way, one was the Miami incident
19 that's been discussed before. I think the total time
20 of that event was about one minute of flight, and the
21 Interflug (ph) incident, the other one that was looked
22 at, was more than that. But the reality is that we had
23 a situation where the airplane had departed from flight
24 and the pilots were actively trying to gain control of
25 that airplane. And as has been previously discussed,

1 once you get into that situation, you're in an area
2 where the regulations are not intended to insure a
3 complete success, necessarily. You can encounter loads
4 that could exceed the capability of the airplane.

5 Q To the best of my knowledge, there's been no
6 finding since the issuance of that AD, is that correct?

7 A That's correct.

8 Q Let's move on to foreign certification. Mr.
9 Offerman, I understand you've been involved in several
10 programs. I know you were not involved in the Dash
11 600-R in its time, but would you please describe to us
12 the FAA's role in foreign certification projects as it
13 would apply to loads and structures?

14 A I could certainly describe my participation
15 in it. As you know, the concept of certification in
16 the United States of a foreign airplane involves a
17 bilateral air worthiness agreement with the foreign
18 authorities, which is achieved after the foreign
19 authority establishes a demonstrated level of
20 competency and the ability to interpret our regulations
21 and find compliance with our regulations.

22 I have personally been involved in the
23 technical sense in evaluating these agencies, and we do
24 go in and look at the systems that the agency has put
25 in place for certification. We look at how they

1 interpret our regulations and insure that they
2 interpret our regulations as we would interpret our
3 regulations, and we take a look at the competence of
4 the people that they have in evaluating the product
5 that they other person turns out as far as being
6 compliant with our regulations.

7 That's at the upper level where these
8 agreements are established. Once these agreements are
9 in place, when a foreign, non-US agency or authority --
10 or company, excuse me, company wants to certify an
11 airplane in the United States, they submit to us their
12 application and information on the airplane. At that
13 point in time, we go and evaluate the airplane, and
14 look at the airplane from the point of view of any
15 unique features, any unusual characteristics, anything
16 on that airplane that we believe that is out of the
17 ordinary. At that point we decide how much
18 participation in that foreign certification we wish to
19 retain for ourselves.

20 If you have an airplane that is a model
21 change for an airplane that we have already been over
22 and has had a satisfactory service history, and we
23 believe that the foreign certification authority is
24 perfectly capable of evaluating that airplane in the
25 light of our regulations, we accept their findings of

1 compliance. In other areas, where we believe that we
2 are in a new area or a unique area, or an unusual area,
3 and we want to retain those findings of compliance for
4 ourselves, we will not allow the non-US agency to find
5 compliance. We will have our own people do that.

6 Q Are you aware of any areas on the Dash 605-R
7 where that was the case, where we actually did take an
8 active roll?

9 A Well, on the 605-R directly, I'm not aware of
10 any areas where we took an active role, per se.

11 Q You may have to go back to --

12 A I'm going to elaborate on that. It is a
13 derivative airplane. There were several areas on the
14 predecessor airplane, for example, the carbon fiber
15 tail, composite tail on that airplane was initially put
16 on the A310, I believe it was, and during the A310
17 certification, we kept the findings of compliance on
18 the design and strength of the carbon fiber tail and
19 the requirements for the evaluation of the graphite
20 tail to ourselves in a certain sense, and we were very
21 active, as an organization, in working very closely
22 with both the manufacturers and the European agencies
23 to set up the design certification and test program for
24 that tail. That's one example.

25 Q Thank you. Have you had a chance to review

1 the FDR data from 587?

2 A Just in a cursory sense, but I'm not part of
3 the accident investigation team.

4 FURTHER QUESTIONING OF MR. HOWFORD

5 BY MR. MURPHY:

6 Q Okay, then. Would you consider the loading
7 on the 587 vertical tail to be a static or impulse type
8 loading?

9 A I would consider it to be a static type
10 loading. It's rapid but relative to speed of
11 structural vibrations, it's not -- I mean it's
12 basically five swings of the rudder in about six to
13 seven seconds, which yes, is quick, but relative to
14 structural vibrations, it is not. So I would consider
15 it basically a static event.

16 Q A static event then. Would you consider the
17 structure to be fully loaded at each rudder input then?
18 The load to be fully developed throughout the vertical
19 tail structure?

20 A If I understand your question -- could you
21 give me that question a different way, please?

22 Q Because it's a static loading then, you would
23 consider the load -- the air load distribution -- then
24 to be fully developed on the surface, and then
25 therefore the internal loads in the structure to be

1 fully developed?

2 A At any particular time for a given rudder or
3 a given side slip angle, yes, I would expect the loads
4 to be per that particular rudder and side slip on the
5 essentially static deformation conditions.

6 Q Thank you. This may be a question that we've
7 -- I'm not even going to address it, the effect of
8 rudder reversal, we've answered that enough today.
9 Based on the information you've seen through the --
10 during the past two days, do you think the response of
11 the aircraft is similar to that response of an aircraft
12 experiencing a Dutch roll? There's been a great deal
13 of conversation with regard to Dutch rolls so far
14 today.

15 WITNESS OFFERMAN: In responding to that, I'm
16 going to, I believe, box in my answer a little bit.
17 I'm going to talk about an airplane of that size and
18 type and that configuration that has a control system
19 that's controlled by the pilot and doesn't have any
20 other modulating influences -- no yaw damper, no
21 autopilot, nothing of that sort.

22 In some of the studies that have been done,
23 the response of the airplane is similar to the studies
24 that have been done on similar airplanes, and that is
25 as you start to cycle the rudder and put in repetitive

1 cyclic inputs, as you approach the Dutch roll
2 frequency, the plane diverges in side slip very
3 rapidly. In about two cycles at the Dutch roll
4 frequency, you can build the load up to above limit
5 load and at about four cycles you can be up as high as
6 ultimate load.

7 That's not an absolute number because under
8 these conditions, there's an awful lot of what has been
9 referred to as roll-yaw coupling, that is what you do
10 with the rudder affects the roll of the airplane; what
11 you do with the wing affects the rudder. This number,
12 a load that you reach, can be modulated by how the
13 pilot works the control. There is a lot of control
14 activity in this kind of thing also. If you just fix
15 the control wheel, the loads get very high. If the
16 pilot responds in one manner, the loads will go down
17 somewhat. If he responds in another manner, they'll go
18 up a little bit, but nonetheless, as you get to these
19 large side slip angles, the airplane becomes very
20 dynamic.

21 MR. MURPHY: I'm just going to finish this
22 out with two questions, then. Was the maneuver
23 condition experienced by 587 covered in certification?

24 WITNESS OFFERMAN: No.

25 WITNESS HOWFORD: No.

1 MR. MURPHY: Okay. Based on your review of
2 the Airbus certification documentation and your
3 discussion since the event with Airbus and the DGAC, do
4 you feel that Airbus has complied with the intent of
5 the previously described regulations with regard to
6 lateral load requirements?

7 WITNESS OFFERMAN: Yes.

8 MR. MURPHY: Madam Chairman, I have no more
9 questions for the witnesses.

10 CHAIRMAN CARMODY: Thank you, Mr. Murphy.
11 Are there other questions from the technical panel.
12 Mr. Clark.

13 QUESTIONING OF MR. HOWFORD

14 BY MR. CLARK:

15 Q Thank you. You commented about the
16 maneuvering in the 587 that you would consider those
17 static loads in the sense that the loads would be fully
18 developed. Can you give me an example of a dynamic
19 load where it takes a period of time for a load to
20 develop? Or what is that period of time that it would
21 take for a load to fully develop?

22 A For the structural dynamics to become
23 important you really have to have loads that change
24 quite rapidly. The kind of conditions that we get that
25 happening in, is flight through discrete turbulence,

1 where there's lots of random fluctuations happening at
2 very high frequency. You would get it in a dynamic
3 landing event where you essentially impact the ground
4 and spin up the wheels and everything is extremely
5 rapid so that excites modes. You can get it in certain
6 blast situations, but that would only be for military
7 type applications.

8 So for aircraft applications, the only time -
9 - for a conventional design of conventional size and
10 conventional vibration characteristics, the only time
11 that it would be warranted to go to the full flexible
12 aircraft model would be for gust analysis or for
13 landing analysis, or one more, taxi -- sometimes taxi
14 can also be a dynamic condition.

15 Q What kind of frequency are we talking about?

16 A It depends -- the structure has many, many
17 modes and many different frequencies. So it depends
18 what you're loading up what kind of frequency you're
19 interested in.

20 Q Back in the tail area. We heard earlier that
21 the natural frequency of the airplane is 0.2 cycles per
22 second, they're five seconds per cycle. And that's
23 going to your static load. How much would we have to
24 detune to -- in the tail area to --

25 A We're getting towards the area of where --

1 obviously there's a borderline. You would not -- you
2 can't say this is static, this is dynamic. And so you
3 have to make a call on that. You're getting into the
4 area where there could be some dynamics taking place,
5 but at a level which I think would not be warranted to
6 include in the analysis.

7 Q So this area --

8 A -- give you anything.

9 Q This 0.2 cycles per second is getting down to
10 an area that you'd have to start watching carefully for
11 dynamic loads?

12 A That's why I mentioned aircraft size, because
13 if you have bigger aircraft where the structural
14 frequency is a lot lower --

15 Q Specifically the A300 --

16 A Exactly, yes.

17 Q The 380?

18 A Oh, sorry, I beg your pardon.

19 Q Well, I'm talking specifically about the
20 A300-600 type model.

21 A I don't believe that the structural
22 vibrations are -- sufficiently slow on the A300-600
23 airplane to have had a significant dynamic component
24 during the events -- the crash event.

25 Q But then, to follow -- how far down can I --

1 how far -- how much of an increase in the frequency do
2 I have to give before you would start getting worried
3 about something going on in the tail? In a dynamic
4 manner.

5 A Well, you're not far away. You're getting
6 there.

7 Q Okay.

8 WITNESS OFFERMAN: I'd like to maybe clarify
9 that a little bit. We seem to be confusing a couple of
10 things. One of them --

11 MR. CLARK: No doubt on my part!

12 WITNESS OFFERMAN: Yes, one of them is the
13 five second cycle, which is a rigid body response of
14 the whole airplane, and the airplane is just kind of
15 wallowing through the air from side to side. That's
16 relatively slow, that's absolutely a static loading.
17 But the fact of the matter is, if you excite the
18 airplane at that frequency, that motion will continue
19 to build until the airplane diverges from its flight
20 path. The other types of dynamics you're talking about
21 is the actual vibration of the structure under load,
22 and if those frequencies are excited, you can have
23 inertial effects. I don't know what the natural
24 frequency of the vertical tail is in its fundamental
25 modes -- would you have an idea?

1 PARTICIPANT: Maybe five hertz.

2 WITNESS OFFERMAN: Okay, five hertz, bending
3 (ph) mode, which is five cycles a second, one cycle is
4 0.2 seconds. The rate of application of the rudder is
5 maximum 60 degrees a second, and 60 degrees a second is
6 considered to be a -- a static type of a load
7 application as far as load buildup goes.

8 MR. CLARK: Okay, alright, let me follow up
9 just quickly then, on the issue of wake turbulence and
10 an encounter there, how should we handle that in this
11 structural consideration -- if there's a potential of
12 some sort of a flow field still acting on the airplane?

13 WITNESS OFFERMAN: In a load sense, at this
14 point in time, we don't consider wake turbulence as a
15 structural loading condition. There's been discussion
16 about what wake turbulence can do to an airplane. The
17 rules and the flight parameters that have been set up
18 around wake turbulence have more to do with loss of
19 control or upset of the airplane than the structural
20 response. It would appear, and the evidence seems to
21 support that at this point in time that the loading
22 that you get from wake turbulence in a structural
23 sense, falls well within the parameters established by
24 the gust load criteria and the maneuverable criteria,
25 for example. I realize there have been papers

1 published that -- and the one presented today is not
2 the only one that discusses the structural loading on
3 wake turbulence. Things like fighters and these types
4 of airplanes generate high loads, but once again, these
5 are based on rather specific scenarios, rather exact
6 conditions that are designed to maximize the effect of
7 wake turbulence and they're done as design studies, not
8 as something that has developed to the point where they
9 would demonstrate a need to change the rules, and
10 certainly the accident evidence to date says that wake
11 turbulence isn't a structural problem.

12 MR. CLARK: Okay, I understand that, but my
13 point is -- let me get myself in a lot of trouble here.

14 I assume that the wake vortex issue in and of by
15 itself isn't a big structural consideration for the
16 most part, for what we're dealing with here.

17 WITNESS OFFERMAN: I think that's what I
18 tried to say.

19 MR. CLARK: Yes, that's -- okay. And then
20 the -- but the -- if I am in a large side slip and I
21 have a large rudder deflection and then I lay on any
22 residual wake vortex or portions of flow field, how
23 should I handle that?

24 WITNESS OFFERMAN: You're talking as a pilot
25 or as a loads analyst?

1 MR. CLARK: Loads.

2 WITNESS OFFERMAN: I just said we don't. And
3 as point of fact, we hadn't much thought about it.
4 While we have evaluated the data that has come out of
5 these incidents to date, the evidence of aircraft in
6 operation indicates it's not a structural problem. I'm
7 not too sure when you talk about wake vortex velocity,
8 that would describe today being in order of ten meters
9 a second, which I think you characterized as what --
10 eight knots, something of that.

11 MR. CLARK: Well, ten meters per second is 20
12 knots ... curves that Airbus developed says that we're
13 down to five knots I think.

14 WITNESS OFFERMAN: But these are numbers that
15 are either on a range where their impact is not very
16 significant or they fall within the range of the
17 existing design requirements for high turbulence gust
18 velocities. Superimposing all of these things one on
19 top of another, for that to happen, there has to be a
20 demonstrated probability that this is a reasonable
21 design condition expected in the operation of the
22 airplane.

23 MR. CLARK: I understand from a design
24 standpoint, but to find out what's going on with this
25 airplane is the issue at hand, sir. Thank you.

1 WITNESS HOWFORD: If I may say, I think it
2 would be an interesting thing -- I mean it's one thing
3 that would be nice to get some firm information about
4 -- I think Hank is right at the moment, we don't have any
5 evidence to suggest that it is a problem, but that's
6 not to say that there may be something in there that we
7 might want to look at. At the moment, I don't think
8 that there's any evidence that it is a problem, though.

9 MR. CLARK: Okay, thank you.

10 CHAIRMAN CARMODY: Anything else from the
11 tech panel? Yes, Dr. Kushner.

12 DR. KUSHNER: Yes, I just wanted to follow up
13 a couple things.

14 QUESTIONING OF MR. HOWFORD

15 BY DR. KUSHNER:

16 Q If we have a five or six hertz system, and
17 it sees loading ramps that go up in the neighborhood of
18 about a second, as in the accident loading, would you
19 qualify that then as completely a static, quasi static
20 load, or would you expect to see some small transient
21 effects?

22 A I would expect to see some transients.

23 Q And in doing the full dynamic analysis, in
24 addition to the relationship between the loading ramp -
25 - you know, time history of the loads and vibration

1 frequencies, are there any other characteristics of the
2 loading field that need to be taken into account in
3 deciding how much of a dynamic effect there is in
4 exciting the vibration modes?

5 A I'm not sure I understand what you mean. If
6 you have something particular in mind?

7 Q Okay, if the vibration mode has a different
8 shape, let's say, than the normal quasi static
9 deformation pattern, then does the loading associated
10 with the static deformation excite the vibration mode?

11 At its full strength, so to speak, in comparison to
12 the static?

13 A I'm sorry I'm afraid I don't quite understand
14 the question. Any loading will excite the structural
15 modes, any kind of loading. Most different amounts to
16 different degree. If you want to be more specific,
17 maybe I can give you an answer.

18 Q Well, in calculating the dynamic response,
19 one needs to take a convolution integral and time of
20 the load with the vibration modes, but in addition you
21 need to integrate the load distribution over the shape
22 of the vibration mode. And so if the shape of the
23 vibration mode is somewhat different than what we would
24 associate with the static deformation, then would you
25 expect to see another difference between the effect of

1 static deformation and the transient?

2 A That's --

3 Q I didn't mean --

4 A Maybe we could talk about that. I'm afraid
5 your mathematics is probably a level higher than mine.
6 It sounds interesting.

7 Q Let's try and avoid that. Thank you.

8 CHAIRMAN CARMODY: Okay, I'll move then to
9 the parties. I would propose starting with American,
10 and then going to Airbus, Allied and FAA. So Mr.
11 Ahearn would you like to begin?

12 MR. AHEARN: Thank you, Madam Chairman, and
13 thank you, gentlemen, good evening. Just a couple
14 topics that I want to discuss with you. It seems to me
15 that through the description and the questions that
16 were raised, that there's varying methodologies to meet
17 the standards, and what I would ask you is do all these
18 varying methodologies to meet the standards result in
19 varying requirements for limit load on a given
20 structure?

21 WITNESS OFFERMAN: As I explained in point of
22 fact, the applicant has a choice of how he chooses to
23 compute his loads and his requirement is to compute
24 those loads in either a rational or conservative
25 analysis. And you can make some very simple

1 approximations, and you can calculate a very good set
2 of loads that will provide a design penalty in the fact
3 that the loads are higher than what the airplane will
4 really see, and the benefit to doing that and accepting
5 the penalty of the increased weight in cost of
6 manufacturer's product is that you do not have a very
7 difficult task of validating that your loads are good
8 loads.

9 Conversely, you can sharpen your pencil, as
10 it were, and use very fine analytical techniques that
11 represent the airplane and compute the loads that are
12 acting on the airplane. In those cases, we require
13 that the applicant go to a great deal of trouble to
14 insure that the data that's used to calculate those
15 loads or these loads that are calculated actually do
16 reflect what the airplane is going to see.

17 And I think the answer to your question is
18 yes, you get different numbers.

19 WITNESS HOWFORD: I've got a slightly
20 different slant on that, Mr. Ahearn.

21 MR. AHEARN: Okay.

22 WITNESS HOWFORD: I guess from my viewpoint,
23 where everybody meets the regulations, we have a
24 certification standard which everybody meets. If
25 people use some simplified criteria, that may be

1 conservative, it may not be. All we know is that we
2 meet our criteria.

3 MR. AHEARN: Okay, but the point of it is
4 that that criteria may be a very large door that one
5 would walk through to meet that criteria. In other
6 words, limited does not necessarily mean limited,
7 depending upon the criteria that is utilized. Is that
8 a correct statement or a fair statement? I know it
9 meets the certification requirements.

10 Let me give you a different example, see if I
11 can help explain it. Given what you just describe to
12 me, would you expect that the A300 and the Boeing 767
13 which are competitive aircrafts of comparable size,
14 would have the same limit loads for their vertical
15 stabilizer?

16 WITNESS HOWFORD: I would expect they would.

17 QUESTIONING OF MR. OFFERMAN

18 BY MR. AHEARN:

19 Q Okay, thank you. Let me move on to another
20 Exhibit. If you need to refer to it, it's something
21 that's been referred to earlier, it's Exhibit 7-F as in
22 Frank, page five and six. This is the operational
23 loads monitoring program that I believe Mr. Offerman,
24 you discussed earlier. In this program where the
25 FAA is monitoring multiple aircraft types from

1 multiple manufacturers, during the time period that
2 you've operated this program, has the FAA ever seen any
3 commanded rudder doublets, other than the ones
4 described on the A310 or the A300?

5 A I'm going to answer that question and then
6 qualify it, if you don't mind. The answer is no, we
7 have not. Now --

8 Q That's fine with me. Go ahead.

9 A But the qualification is that this is a
10 voluntary program that provides data for us for
11 operational loads monitoring for the use in helping us
12 determine appropriate methods for the application of
13 our damage tolerance and fatigue rules. And what we're
14 interested in the standard operational data. The
15 airline is permitted to, and we accept this as part of
16 the data collection, to clip unusual events from the
17 data set that's given to us as they sanitize it, as you
18 were. So if they have a situation where a pilot has
19 exceeded a requirement or something has happened to the
20 airplane that is an unusual event, that is not part of
21 the daily operational characteristics of their
22 airplanes, the airline can take that data out.
23 Sometimes they don't, then we do get these peaks that
24 raise hell with our statistical analysis, but
25 nonetheless, we don't know what has been removed from

1 that database when it was given to us.

2 Q Okay, thank you. Let me just as a question.

3 in the same database, have you seen any vertical
4 stabilizers reaching limit and ultimate loads, other
5 than on the aircraft types -- the A310 or the A300?

6 A The load distribution charts are -- flow
7 level distribution charts that I have seen have not
8 exhibited that.

9 Q And in your time period, are you aware of any
10 other transport category aircraft that has suffered a
11 vertical fin separation?

12 A Again, that's a difficult question to answer
13 because historically, in modern times -- and I consider
14 modern times to be post-World War II -- as you will
15 recall over the years there have been a number of
16 inflight breakups of aircraft, and some of those were
17 separation of vertical fins. Some of those were, in
18 fact, fuselage separating, some were wings coming off,
19 and they have been as recent as the Turkish Airlines
20 737 that, for apparent reason -- no apparent reason
21 came apart in flight. And these have been attributed
22 to flights into extremely turbulent weather and that
23 the loss of the airplane was a result of either
24 divergence in control flight, overload trying to
25 recover flight, or just plain overload and turbulence.

1 And so to say -- the question, do you know of any
2 where the fin has come off? Yes, I do. Do I know of
3 any where the fin has come off under the circumstances
4 that existed to this airplane, which is a rather benign
5 meteorological environment on a rather nice day, no, I
6 don't. I have gone through three databases -- European
7 and US databases back to World War II is what I've
8 concentrated on, I could find no record of that.

9 Q Okay, thank you. You must be thinking at
10 this late hour, because that was my next question. Let
11 me go to just a different subject here, and Mr.
12 Offerman, I want to direct this question to you. It's
13 my understanding that you worked on the transition from
14 the B2/B4 to the 310 composite?

15 A No. No, I didn't.

16 Q You did not. Then I must have misunderstood
17 what you said earlier. Can you clarify your knowledge
18 of the transition from the B2/B4, the metal fin, to the
19 composite fin.

20 A The transition was a historical search at the
21 time. After the accident, as we were reviewing the
22 aircraft certification and qualification data, however,
23 our national resource specialist, Joe Soderquist (now
24 retired), actively participated in the composite design
25 and certification program, and also our fatigue and

1 damage tolerance national resource specialist, Tom
2 Swift, was involved in that. On the predecessor
3 airplanes, Terry Barnes, Mr. Howford's predecessor was
4 actively involved in that airplane also, in reviewing -
5 - this is the A300 series and later on.

6 Q Do you have any knowledge of the robustness
7 of the vertical stabilizer and the difference between
8 the metal fin and the composite fin?

9 A Superficial.

10 Q Anything you want to comment about? Whether
11 one was stronger than the other?

12 A I don't know the strength of the metal fin.

13 Q Okay.

14 A That's a simple statement. I -- the areas
15 that we looked into on the certification with reference
16 to the metal fin was the flexibility characteristics of
17 the fin, the structural stiffness of the fin to be sure
18 that the data carried from one airplane model to the
19 other was applicable.

20 Q And just one final question or topic that
21 would help, especially if you gentlemen would, do you
22 have any sense as to why the AD or safety
23 recommendation that was issued as a result -- or post
24 the 587 accident you highlighted two events, one in
25 1991 the Interflug (ph), I believe you referred to it

1 as, and the event in 1997 with our airplane, flight
2 903, why the AD was not issued subsequent to either one
3 of those events?

4 A I can't answer that with any degree of
5 certainty. I wasn't a participant. I do know that the
6 airplanes went through those events. The events were
7 reported as being extreme events. One of them was
8 investigated as an accident. The airplanes went
9 through the appropriate inspection procedures that
10 existed at the time and there was no apparent damage to
11 either of the airplanes that I'm aware of, and the
12 airplanes returned to service. This is the standard
13 procedure that existed at the time. It's only
14 retrospectively that we became aware of the significance of
15 these events with regard to structural loading.

16 MR. AHEARN: Okay, gentlemen, thank you for
17 your time, and Madam Chairman, that ends my questions
18 for this evening. Thank you.

19 CHAIRMAN CARMODY: Thank you. Airbus, Dr.
20 Lauber.

21 DR. LAUBER: I have one very quick question.

22 QUESTIONING OF MR. HOWFORD

23 BY DR. LAUBER:

24 Q With regard to the operations load monitoring
25 program, the FAA program, do you record -- what are the

1 parameters recorded, specifically with regard to
2 lateral?

3 A I'm afraid I can't be very specific. I
4 haven't yet had time to familiarize myself with
5 everything that is in that database, but it does
6 include NY.

7 Q Pardon me?

8 A It does include NY, the lateral acceleration.

9 Q It includes NY, does it include sufficient
10 information that you can actually go back and compute
11 fin loads?

12 A No, I don't think we have -- if we have the
13 rudder angle, and I don't know if we do, then we could.
14 But I'm afraid I can't answer your question, because I
15 don't know that.

16 WITNESS OFFERMAN: The answer to that is no.
17 We've looked at that database precisely to -- that
18 evaluation, and we don't have any information on side
19 slip angles, for one.

20 DR. LAUBER: Okay, thank you. That's all the
21 questions we have.

22 CHAIRMAN CARMODY: Thank you. On to Allied
23 Pilots, Captain Pitts.

24 CAPTAIN PITTS: Thank you. Gentlemen, you
25 certainly have the qualifications to talk about a

1 number of subjects, I hope I don't touch upon any that
2 you're not comfortable in talking about now, if so,
3 please just advise me. Seems a very complex topic.
4 We've talked about natural vibration frequencies and
5 loads and external excitations, and it's very difficult
6 for us all to put together. Can either of you comment
7 on what the approximate time required for Dutch roll to
8 develop to an amplitude that would be recognizable to
9 the pilot, such as the Dutch roll that's been spoken to
10 earlier?

11 WITNESS OFFERMAN: My answer to that is no.

12 QUESTIONING OF MR. HOWFORD

13 BY CAPTAIN PITTS:

14 Q Mr. Howford?

15 A I was going to -- perhaps I could ask you to
16 repeat the question, please.

17 Q The approximate time required for a Dutch
18 roll to develop to the point where a pilot would be
19 able to recognize it as a Dutch roll?

20 A I guess I could offer an opinion, but I'm not
21 sure.

22 Q Okay. Could tangential entry into an
23 external flow field, such as a wake vortices provide
24 the necessary energy for the aircraft to initiate a
25 Dutch roll?

1 WITNESS OFFERMAN: I'm going to take my crack
2 at it. If the yaw damper was on, that would be a
3 precluded event, I believe, unless -- no, if the yaw
4 damper was on that would be precluded. For the
5 initiation of a Dutch roll, any disturbance could
6 initiate an airplane motion. If the disturbance was a
7 -- at that frequency or harmonic of that frequency you
8 could excite Dutch roll, but in the absence of
9 continued disturbance, it would damp itself out. Dutch
10 roll is slower than ...

11 WITNESS HOWFORD: I have a response also.
12 The Dutch roll is being excited all the time, every
13 time you fly through the atmosphere that isn't
14 perfectly smooth, there is Dutch roll and that's why
15 you have the yaw damper. So, undoubtedly, if you flew
16 through some non-still air you probably will excite a
17 degree of Dutch roll but this is a different phenomenon
18 from having a forced Dutch roll, when you take that
19 particular mode and excite it by a bit of a -- or force
20 it with a rudder. I think it's probably quite
21 different.

22 QUESTIONING OF MR. OFFERMAN

23 BY CAPTAIN PITTS:

24 Q Alright, now, were you present to hear the
25 discussions about the different degrees per second

1 travel rates of the rudder versus the yaw damper?

2 A Yes.

3 Q And are you familiar with the graph where we
4 see the yaw damper move initially opposite rudder
5 deflection and then after approximately two and a half
6 swings, now moving in the same direction as the rudder?

7 A I remember the discussion of the plot.

8 Q Alright, sir. Would yaw damper in that mode
9 help us avoid this situation that you spoke of, if the
10 yaw damper were working?

11 A If I'm answering the question I think you're
12 asking, there would be a noticeable or a calculable
13 difference, but it wouldn't be significant. Some of
14 the studies that have been done have the actions of the
15 pilot in tune with the actions of the yaw damper such
16 that you can get some coupling between the pilot and
17 the yaw damper, but the effect is rather negligible.

18 FURTHER QUESTIONING OF MR. HOWFORD

19 BY CAPTAIN PITTS:

20 Q Mr. Howford? Would you have the same
21 response?

22 A Is there a question as to whether or not the
23 presence of a yaw damper upstream or downstream will
24 have a beneficial impact on loads?

25 Q It was back referencing the tangential entry

1 with the external flow field. The original question
2 was that with a functioning yaw damper, the excitation
3 to Dutch roll would be negligible. But if the yaw
4 damper had now moved into a position or a condition, I
5 should say, as we saw on the third swing of the rudder
6 as depicted on the graph -- we can bring the graph back
7 up if you need the visual of it --

8 A If it's going to be a controls systems issue,
9 I'm probably not going to be able to help you anyway.
10 If it's kind of a feedback, I -- I wouldn't know.

11 Q Okay. And I'm not asking you to comment on
12 control design. Does the delay input/output lag --
13 first off, let me ask you this. You referenced the
14 work by Mr. Brown, I believe you did, Mr. Offerman.

15 FURTHER QUESTIONING OF MR. OFFERMAN

16 BY CAPTAIN PITTS:

17 Q Would the delay input/output lag referenced
18 in that document, and associated with the flight
19 controls, does it help or hinder us in a Dutch roll
20 recovery?

21 A I'm not qualified to answer that question.

22 Q Okay. You spoke a little bit about loads and
23 once the loads developed and what a pilot could do, and
24 it was a little shocking really. What recovery
25 procedure, for the Dutch roll, what would it look like

1 or consist of if they found themselves in this
2 condition where they felt as if they had loaded the
3 vertical tail plane to the point that they were
4 approaching the ultimate limit?

5 A I couldn't even speculate on that. It's just
6 an area that I have no expertise.

7 Q Is there a way that you, in terms of load
8 relief, is there a way that you know to relieve the
9 load? It almost appeared that -- from your discussion,
10 that regardless of which way you moved, you were
11 between a rock and a hard place.

12 A Under those conditions, an appropriate move
13 would be to just release the controls and allow them to
14 return to neutral. That would be one way to reduce it.

15 WITNESS HOWFORD: My comment also. Stop
16 forcing it.

17 BY CAPTAIN PITTS:

18 Q Have you looked at how this structure load
19 relieved?

20 A With regard to the computation of the loads?

21 Q Yes, sir.

22 A Yes. Again, it's -- I haven't gone into the
23 checking of the mathematics of the work that the folks
24 have done, but I have looked at the methodologies
25 they've used and the data they generated.

1 Q Is there any difference of significance in
2 the methods that manufacturers use for this vertical
3 tail plane and how it may have been designed, or where
4 the yield point may have been to have effected the
5 outcome of this event?

6 A From my own personal experience in being
7 involved in this, the methodology that was used was
8 very appropriate and it was very sophisticated in
9 analysis. With regard to the confidence in the data
10 that came out of that, we believe it met the
11 certification standards to Part 25.

12 Q Alright, sir, in reference to Part 25 and
13 side slip requirements, do you know of any manufacturer
14 that tests in excess of the FARs concerning reversal of
15 the rudder at max beta?

16 A I have been involved in one test program like
17 that in my life, and that was the application of a
18 civilian airplane to a military application, and what
19 were required to fly the military envelope and
20 demonstrate the military maneuvers and we bent the aft
21 fuselage.

22 Q Mr. Howford?

23 WITNESS HOWFORD: I'm not aware of any such
24 case.

25 BY CAPTAIN PITTS:

1 Q With that in mind, we've spoken to this event
2 as being somewhat remote, but rather severe maybe,
3 arguably catastrophic. A quick assessment of the risk
4 puts that fairly high. Would both of you please
5 comment on your thoughts about the suitability of the
6 FARs to protect us from such a condition and how they
7 speak to this hazard?

8 A I think the first statement is that from the
9 time of the accident, and the time the accident -- our
10 knowledge of the accident evolved and some of the
11 circumstances, we have seriously considered types of
12 things that could be done to the regulations, if it was
13 required, to preclude this accident from happening.
14 And there are many approaches that cover the gamut from
15 simply making the airplane stronger, to changing the
16 way pilots are trained.

17 One of the things that we recognize is that a
18 Part 25 airplane, designed to that specification, is
19 intended for operation of Part 121 environment, and
20 that includes the operational modes of the airplane,
21 the operational limitations on the airplane, the
22 training of the pilots, the maintenance of the
23 airplane, and of course, Part 25 is the construction of
24 the airplane, and Part 21 is the manufacture of the
25 airplane. And it's all of these put together that

1 create this safety level that we have today, and I
2 certainly believe that as the -- when the NTSB Board --
3 the National Transportation Safety Board issues its
4 findings, we will certainly evaluate the regulations
5 throughout the entire range of those regulations and
6 determine what will be the most appropriate way to
7 improve the level of safety with regard to this type of
8 accident, if it's believed that that's the right thing
9 to do.

10 The thing that we don't want to do is make a
11 change to the regulations that's a 'feel good' change,
12 that ends up making everybody believe that the
13 airplanes are safer, when in reality, they're not. I
14 mean, for example, strengthening the airplane seems to
15 be an obvious choice, but some of the things that have
16 been proposed to put into regulation to strengthen it
17 wouldn't have prevented that accident, and we certainly
18 don't want to do that kind of thing.

19 But we're going to be waiting for the NTSB
20 findings to determine what might be done. In the
21 meantime, we certainly have started to put together a
22 list of those things which could impact this or affect
23 it.

24 FURTHER QUESTIONING OF MR. HOWFORD

25 BY CAPTAIN PITTS:

1 Q Mr. Howford?

2 A Yes, I agree with Mr. Offerman that obviously
3 we've got a very serious accident here. We've got to
4 look and see if there are any changes required.

5 I just want to offer one comment, and that is
6 that when we do the rudder kick maneuver, it is of
7 course a canned maneuver and it's stylized maneuver and
8 we don't do a doublet, we do a single kick. But we do
9 a number of things. We look over a speed range. We
10 look at the maximum weight. We look at the worst
11 weight. We look at the worst inertia, the worst
12 altitude.

13 And in a number of situations that it's
14 sufficient to provide strength to allow a doublet, and
15 for evidence of that, look at the first three peaks of
16 flight 587. In fact their rudder went, one, two,
17 three, and I believe that the Airbus load prediction
18 will show that the loads were still, at least on the
19 second pulse, were still around -- not much above
20 limit.

21 So there could be circumstances where, for
22 instance, if you put a very fast rudder input in and
23 then reverse it before the side slip has chance to
24 develop, you will not get this big loading case. You
25 get associated with putting the rudder in, allowing the

1 side slip to build up and then reversing it in phase
2 with a Dutch roll frequency. So timing is very
3 important in getting those big loads, and there could
4 be events where doublets would be okay.

5 What -- this regulation has been around since
6 the 1950's, hasn't changed, not in any significant
7 degree, and as Mr. Offerman said, we do not have a
8 history of this kind of failure. So yes, we have to
9 look at what -- certainly before this going in
10 position, would be that we have had a satisfactory,
11 certifiable criteria. We have to wait until the end of
12 this hearing to find out where we want to be.

13 FURTHER QUESTIONING OF MR. OFFERMAN

14 BY CAPTAIN PITTS:

15 Q Thank you, and just one last question. In
16 light of the previous discussion of gross weights of
17 aircraft and that impact on the vortex strength, just
18 from a loads -- but I might ask you to speculate a
19 little bit about handling characteristics -- would you
20 agree that we need to move forward in adjusting the
21 regulations, if, in fact, that's what happens with
22 greater knowledge of the impact and the overall effect
23 of vortices?

24 A I can't answer that directly. I can tell you
25 that there has been a very large transport group formed

1 and one of their objectives is to study the impact of
2 the larger airplanes such as the new 380 coming along,
3 a million-pound plus airplanes, and the effect of those
4 vortices. So it's not a subject which is disappearing
5 or being ignored. Beyond that I can't make any further
6 statements.

7 CAPTAIN PITTS: Any further comment? Mr.
8 Howford? Thank you gentlemen very much. I have no
9 further questions.

10 CHAIRMAN CARMODY: Thank you, FAA, Mr.
11 Donner.

12 MR. DONNER: No questions. Thank you, ma'am.

13 CHAIRMAN CARMODY: Very good. Are there any
14 additional questions from the technical panel? Seeing
15 none, any additional questions from the parties? Let
16 me just mention -- the Exhibit that American requested
17 earlier will be added. It will be Exhibit 2-N as in
18 Nancy and that's pages four a, b, and c.

19 The document, previously
20 requested by American Airlines
21 was marked as Exhibit 2-N, was
22 entered into evidence.

23 CAPTAIN PITTS: Thank you, ma'am.

24 MEMBER GOGLIA: The Board?

25 CHAIRMAN CARMODY: The Board. I'm sorry.

1 The hour is late. Member Goglia.

2 MEMBER GOGLIA: I have a question for Hank.

3 CHAIRMAN CARMODY: It's a good thing somebody
4 keeps me straight up here.

5 QUESTIONING OF MR. OFFERMAN

6 BY MEMBER GOGLIA:

7 Q Hank, I have a question. I need to ask you
8 to help me answer a question that has been raised by
9 many folks as I travel around. It's not -- it's a
10 simple question, I don't think there's a simple answer.

11 But how do we, the government, the protector of the
12 traveling public, allow an airplane to be certified
13 that can have a failure of primary flight control
14 system, like simple operation of the flight controls,
15 by a flight crew member? I have been unable to answer
16 that question that's been asked to me.

17 Q I'm going to take a stab at that, and I hope
18 I'm not getting myself into something I wished I
19 hadn't. But the reality is that in the pitch plane,
20 for example, the pilot can break the wings of an
21 airplane by misapplication of the controls. I'm not
22 sure about the roll axis, whether that's possible, but
23 as we've discovered, it certainly is possible about the
24 yaw axis, also.

25 And the regulations, again, are built around,

1 for example, for Part 25 airplane, are built around
2 Part 121 transportation operations and it is expected
3 that the pilot is trained to stay inside those
4 operation limitations, either implied or expressed.
5 And beyond that, the system, at this point in time, up
6 until this accident, has seemed to have resulted in
7 airplanes that had a high degree of safety when
8 operated that way, and beyond that point, I don't have
9 an answer.

10 Q You did raise an interesting point, though,
11 trained to stay inside. That would imply that there is
12 some training in some limitations that are conveyed to
13 the flight crew, and the manner in which it's received.
14 You can say things and it's not received. In training
15 you would expect that it is said in such a way that it
16 is received.

17 A And I'm not a training person. I'm not
18 really qualified to address it on behalf of the FAA.
19 They have their own organization that handles that kind
20 of thing.

21 MEMBER GOGLIA: Okay, thanks. I've been
22 hammered by that. I just thought I'd share it. No
23 further questions.

24 CHAIRMAN CARMODY: Member Black? No
25 questions. I think we are through then for the

1 evening. Let's resume tomorrow morning at eight
2 o'clock. Thank you very much, Mr. Howford and Mr.
3 Offerman for your contribution and your time and your
4 testimony.

5 (The witnesses were excused.)

6 CHAIRMAN CARMODY: Adjourned until tomorrow.

7 (Whereupon, at 5:51 p.m., the hearing in the
8 above captioned matter was adjourned, to be reconvened
9 tomorrow morning, Thursday, October 31, 2002, at 8:00
10 a.m.)